O‘ZBEKISTON RESPUBLIKASI OLIY TA’LIM, FAN VA INNOVATSIYALAR VAZIRLIGIABU RAYHON BERUNIY NOMIDAGI URGANCH DAVLAT UNIVERSITETI

“QURILISH VA ARXITEKTURA SOHASIDAGI INNOVATSION G‘OYALAR, INTEGRATSIYA VA TEJAMKORLIK”

УРГЕНЧСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ ИМЕНИ АБУ РАЙХАНА БЕРУНИ

РЕСПУБЛИКАНСКАЯ НАУЧНО-ПРАКТИЧЕСКАЯ КОНФЕРЕНЦИЯ «ИННОВАЦИОННЫЕ ИДЕИ, ИНТЕГРАЦИЯ И ЭКОНОМИКА В ОБЛАСТИ СТРОИТЕЛЬСТВА И АРХИТЕКТУРЫ»

IN THE NAME OF ABU RAYHAN BERUNI URGANCH STATE UNIVERSITY

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To‘plamga kiritilgan maqolalar mazmuni, ilmiy salohiyati va keltirilgan dalillarning haqqoniyligi uchun mualliflar mas’uldirlar.

ADVANCING ENERGY EFFICIENCY OF BUILDINGS VIA STRUCTURAL AND TECHNICAL MEASURES IN UZBEKISTAN'S CONTEXT

Shermatova Makhbuba[1], Dinara Nazarova[2]

[1]Civil Engineering and Architechture, Turin Polytechnic University in Tashkent, Uzbekistan, E-mail-*m.shermatova@polito.uz*

[2]Civil Engineering and Architechture, Turin Polytechnic University in Tashkent, Uzbekistan

Abstract

Energy efficiency in the building sector represents a key component of sustainable development, especially in countries exposed to severe climatic conditions like Uzbekistan. The present study examines structural and technical approaches aimed at improving the energy performance of buildings within this context. It reviews prevailing practices, identifies challenges, and evaluates possible solutions, with particular attention to passive and active design strategies, the use of advanced construction materials, and the incorporation of renewable energy systems. Furthermore, the research proposes recommendations for policy enhancement and outlines practical measures for effective implementation.

Keywords

Energy efficiency, passive design strategies, renewable energy, HVAC systems, building management systems.

Introduction

Energy efficiency in the building sector represents a key component of sustainable development, especially in countries exposed to severe climatic conditions like Uzbekistan. The present study examines structural and technical approaches aimed at improving the energy performance of buildings within this context. It reviews prevailing practices, identifies challenges, and evaluates possible solutions, with particular attention to passive and active design strategies, the use of advanced construction materials, and the incorporation of renewable energy systems. Furthermore, the research proposes recommendations for policy enhancement and outlines practical measures for effective implementation.

Overview of Energy Consumption in Uzbekistan's Building Sector

The construction sector ranks among the largest energy consumers globally, responsible for nearly 40% of total energy demand and associated carbon emissions. Since buildings typically operate for several decades, this sector holds a critical position in advancing energy-saving measures aimed at reducing ecological impacts and contributing to worldwide climate change mitigation. Uzbekistan, similar to many other nations, encounters comparable issues, as its building stock represents a substantial share of national energy use [1].

As a fast-growing Central Asian country, Uzbekistan has experienced a steady increase in energy demand across multiple sectors, particularly in buildings. The nation's harsh climatic conditions, with seasonal extremes from –35 °C in winter to +40 °C in summer, strongly influence the energy requirements of the built environment. According to the International Energy Agency, the building sector alone accounts for over 30% of Uzbekistan's total primary energy consumption, as illustrated in Figure 1 [17].

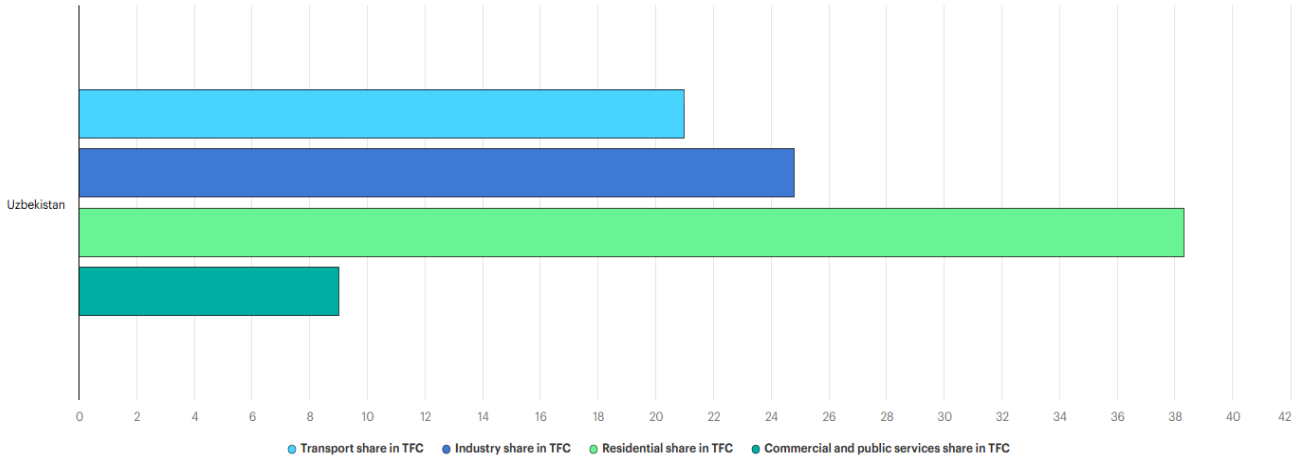

Figure 1. Total final energy consumption of Uzbekistan in 2022

Energy consumption in Uzbekistan's building sector is shaped by a variety of factors, such as the age and physical condition of the building stock, the prevalence of inefficient heating and cooling systems, and the slow pace of adopting modern energy-saving technologies. The implementation of efficiency measures is further constrained by several obstacles. A prominent issue is the large share of buildings

constructed during the Soviet period, which generally lack contemporary energy-efficient design elements. Limited financial resources and insufficient incentives also discourage property owners from undertaking energy efficiency upgrades.

Another barrier lies in the relatively low awareness among building owners, architects, and construction professionals about the long-term advantages of energy-efficient design and technologies. This knowledge gap frequently leads to less effective construction choices and hesitation to introduce innovative solutions. Institutional and policy-related constraints add to the challenge, as Uzbekistan's gradual shift from a centrally planned system to a market economy has slowed the development of comprehensive energy efficiency policies.

Addressing these issues requires an integrated, multi-dimensional strategy. Retrofitting existing buildings with thermal insulation, efficient HVAC systems, and modern lighting and appliances represents one important pathway. Likewise, applying passive design principles—such as optimizing orientation, enhancing natural ventilation, and making use of passive solar heating—can help reduce energy use without demanding large-scale structural modifications.

In addition, the deployment of renewable energy technologies, including solar photovoltaic installations and ground-source heat pumps, can strengthen overall energy efficiency while cutting dependence on fossil fuels and lowering carbon emissions from the building sector.

Structural Measures for Optimizing Energy Use

Fundamental passive design measures—such as optimal building orientation, site layout, effective thermal insulation, and natural ventilation—are essential for improving the energy efficiency of buildings. Correct orientation reduces unwanted solar heat gain in the summer while enabling passive heating benefits during colder months [2][3]. Careful site planning that incorporates vegetation, shading devices, and open spaces can further enhance energy performance. The use of advanced insulation for walls, roofs, and floors minimizes heat transfer, ensuring stable indoor temperatures, greater thermal comfort, and reduced energy demand [4][5]. In parallel,

promoting natural ventilation and daylighting helps to decrease dependence on mechanical cooling and artificial lighting, thus lowering overall energy consumption [6].

Equally important is the application of innovative construction materials. High-efficiency options such as aerogels, vacuum insulation panels, and specialized foams provide superior thermal resistance and energy conservation benefits. Reflective coatings and phase change materials regulate indoor microclimates by storing and releasing heat, thereby strengthening overall building performance. At the same time, using regionally available resources—such as adobe and compressed earth blocks—not only reduces embodied energy but also improves sustainability outcomes [3][7].

Evidence from research underscores the effectiveness of integrating passive and bioclimatic solutions for energy conservation and comfort enhancement. For instance, the use of indigenous materials such as limestone and hemp-based natural fiber insulation has been shown to significantly decrease thermal loads in buildings [5][8]. Local construction practices demonstrate strong potential to maintain indoor comfort conditions while reducing reliance on external energy sources.

Sustainable building strategies, including advanced glazing technologies, renewable energy systems, and eco-friendly resources like bamboo, also contribute to considerable reductions in energy use. Studies consistently affirm that the adoption of these approaches leads to lower energy consumption and greater environmental sustainability [9].

In conclusion, the integration of passive design techniques, energy-efficient materials, and sustainable construction practices is fundamental to achieving higher levels of building energy efficiency.

Technical Solutions for Optimizing Energy Use

With the global shift toward sustainability, improving the energy efficiency of buildings has become a central priority. Heating, Ventilation, and Air Conditioning (HVAC) systems represent one of the largest contributors to overall building energy use [10]. Modern energy-efficient HVAC technologies—such as heat pumps and

variable refrigerant flow systems—are designed to reduce energy losses while delivering high performance [11]. Smart thermostats further enhance efficiency by learning occupant behavior and adjusting temperature settings automatically, ensuring energy is consumed only when necessary. Moreover, heat recovery ventilation systems recapture waste heat, thereby increasing the overall effectiveness of HVAC operations [12].

The integration of renewable energy solutions also plays a vital role in reducing energy demand from conventional sources. Solar photovoltaic arrays and solar thermal systems provide clean electricity and hot water, while geothermal heat pumps exploit stable underground temperatures to deliver efficient year-round conditioning [13]. Complementary options such as small-scale wind turbines and hybrid energy systems can help meet additional energy requirements.

Advanced Building Management Systems (BMS) contribute further by enabling real-time monitoring and automated control of energy flows. IoT-based solutions with intelligent energy monitoring allow dynamic adjustments to optimize performance [14]. Participation in demand-response programs enables buildings to adapt their consumption patterns according to grid conditions, improving overall energy efficiency [15]. In addition, AI-supported predictive maintenance enhances system reliability by identifying and addressing potential equipment issues before they escalate [16].

A holistic strategy that combines high-performance HVAC solutions, renewable energy technologies, and smart building management tools is therefore essential for achieving significant improvements in building energy efficiency.

Conclusion

Uzbekistan’s building sector is confronted with major energy-related challenges, largely driven by its harsh climatic conditions and outdated building stock. Since this sector represents a considerable portion of the nation’s overall energy use, enhancing efficiency is crucial to reducing demand, cutting greenhouse gas emissions, and improving indoor living conditions.

This research emphasizes the importance of adopting an integrated approach to energy efficiency in Uzbekistan's buildings. Passive design solutions—such as strategic building orientation, effective thermal insulation, and improved natural ventilation—can significantly decrease heating and cooling loads. At the same time, the use of modern construction materials and sustainable design practices strengthens energy conservation while supporting broader environmental objectives.

From a technical standpoint, upgrading HVAC infrastructure, deploying intelligent energy management systems, and utilizing renewable technologies—including solar photovoltaic installations and geothermal heat pumps—can greatly enhance building performance. The application of IoT-enabled building management platforms and AI-based predictive maintenance provides further opportunities to optimize energy consumption and operational reliability.

For long-term advancement, national policies must prioritize energy-efficient retrofitting programs, provide incentives for sustainable technology adoption, and raise public awareness of energy-saving measures. By combining structural innovations with advanced technical solutions, Uzbekistan has the potential to develop a more energy-efficient building sector that contributes to national energy security and aligns with global climate commitments.

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AVTOMOBIL YO‘LLARI SEMENTOBETON QOPLAMASINI MUZGA CHIDAMLILIGINI OSHIRISH

prof.A.Xamidov, dots.F.Nishonov, o‘qit.S.Xakimov, tadqiq. I.G‘aniev

Namangan davlat texnika universiteti

(tel.90 214 88 22)

Annotatsiya

Avtomobil yo‘llar sementobeton qoplamasining muzga chidamliligini oshirish uchun beton qorishmasiga havoni kiritish va qoplamaning yuza qismini tuzga chidamliligini va turg‘unligini ta’minlashdir. Maqolada sementobeton qoplamasining muzga chidamliligini oshirish uchun beton qorishmasiga kiritilgan havoning me’yoriy miqdorini ta’minlash muammolari va uni yechimi masalalari yoritilgan.

Kalit so‘zlar

Avtomobil, yo‘l, qurilish, ssementobeton, qoplama, beton qorishmasi, muzga chidamlilig havo, g‘ovaklar, qo‘shimchalar, suv-sement nisbati.

Kirish

Yo‘l qoplamalar ishonchliligi, ishlash qobiliyati va mustahkamligiga qo‘yiladigan talablarni oshishi transport vositalar yuk ko‘tarish qobiliyatini oshishi va yo‘llardagi harakatlar intensivligiga bog‘liq [1].

O‘zbekiston va dunyo tajribasi shuni ko‘rsatmoqdaki, yo‘llarga qo‘yiladigan talablarga ko‘p jihatda sementobeton qoplamali avtomobil yo‘llari javob beradi [2].

Shuni ta’kidlash lozimki, sementobeton qoplamalar qurilishi alohida yondashish va e’tiborni, to‘la texnik ta’minotni, ijrochilar yuqori malakasini, qurilishni optimal tashkil etishni talab qiladi.