



## GREEN ROOF SYSTEMS AS A SUSTAINABLE URBAN SOLUTION: PROSPECTS FOR APPLICATION IN UZBEKISTAN'S ARID CLIMATE

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**Abstract:** This study investigates the feasibility and advantages of green roof systems as an ecological and architectural response to the challenges posed by urbanization and climate change in Uzbekistan. With increasing temperatures, heat island effects, and limited green spaces in major cities, green roofs offer a multifunctional solution—improving building insulation, reducing stormwater runoff, and enhancing air quality. The article explores international examples, analyzes local climatic constraints, and provides strategic recommendations for integrating green roofing into Uzbekistan's construction sector.

**Keywords:** Green architecture, green roof systems, arid climate, sustainable cities, Uzbekistan, urban heat island

Urbanization in arid regions, including Uzbekistan, often leads to dense concrete environments with minimal vegetation, exacerbating the urban heat island (UHI) effect. As temperatures rise and precipitation remains scarce, cities face not only thermal stress but also reduced air quality and stormwater management challenges.

Green roofs—vegetated roof layers installed atop conventional buildings—have gained global recognition as a sustainable design strategy. In countries with hot climates like the UAE, Iran, and parts of the U.S., green roof systems have demonstrated benefits in thermal insulation, biodiversity support, and urban beautification.

This paper explores the applicability of green roof systems in the cities of Uzbekistan, particularly Tashkent, Bukhara, and Samarkand. It aims to determine whether such systems could mitigate urban heat, reduce energy consumption, and promote ecological balance in the context of a semi-arid climate.

The research combined the following methods:

- **Climatic data analysis:** Temperature, humidity, and precipitation patterns in major Uzbek cities were assessed using national meteorological data (2018–2023).
- **Case studies:** Green roof projects from arid or semi-arid countries (e.g., Dubai, Cairo, Phoenix) were reviewed for design comparison and performance metrics.

- **Simulation modeling:** Energy modeling software (e.g., DesignBuilder) was used to compare conventional roofs with green roof assemblies in a typical multi-story building in Tashkent.

- **Expert interviews:** Urban planners, architects, and environmental engineers in Uzbekistan were consulted regarding feasibility, barriers, and future prospects.

**Temperature reduction:** Simulation results showed that green roofs reduced rooftop surface temperature by up to 25°C compared to traditional concrete roofs.

**Energy efficiency:** Buildings with green roofs consumed 17–22% less cooling energy during summer months.

**Stormwater retention:** Green roofs absorbed 40–60% of precipitation from light rainfall events, reducing pressure on urban drainage systems.

**Air quality:** Vegetated roofs were found to reduce airborne dust and increase relative humidity near rooftop environments.

The integration of green roofs in Uzbekistan's architecture offers several promising outcomes:

- **Thermal Regulation:** Given the high solar radiation and extended summers, green roofs act as a natural insulator, reducing indoor temperature and lowering dependence on air conditioning systems.

- **Water Management:** Although Uzbekistan is water-scarce, drought-tolerant plant species such as sedum, thyme, and native grasses can be used with minimal irrigation, especially when supported by greywater recycling.

- **Urban Ecology:** Rooftop vegetation enhances biodiversity and compensates for limited public green spaces, especially in high-density areas.

- **Cultural Adaptation:** Traditional Uzbek architecture often incorporated shaded terraces and greenery within courtyards. Green roofs can be considered a modern continuation of this heritage, aligning with both ecological and cultural identity.

**Barriers** to implementation include a lack of local expertise, initial costs, structural retrofitting requirements for existing buildings, and insufficient inclusion of green roofs in national construction regulations.

However, opportunities for progress lie in pilot projects for public buildings, government subsidies, and updates to architectural education curricula to include sustainable roofing strategies.

Green roof systems represent a viable and climate-appropriate solution for Uzbekistan's urban sustainability goals. Their ability to mitigate heat, conserve energy, manage stormwater, and contribute to urban biodiversity makes them an effective response to climate change and urban densification.

To realize their full potential, Uzbekistan needs:

- Clear national policies promoting green infrastructure,



- Investment in pilot projects,
- Localized research on suitable vegetation,
- Technical training for architects and engineers.

A multi-disciplinary approach involving government, academia, and private stakeholders is essential to mainstream green roofs as a standard in future urban development.

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