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MODERN APPROACHES TO URBAN GREENING

Abstract. *This article explores modern approaches to building greening, their types, and their impact on the urban environment. It outlines the ecological benefits of green roofs, vertical greening, integrated landscape solutions, and proposes a new greening method that contributes to pollution reduction, microclimate improvement, and increased energy efficiency of buildings.* ***Research*** *Methods. Through comparative analysis, this study examines various greening methods (green roofs, facade greening, etc.) and their ecological and economic advantages. The integration of tactical urbanism principles with innovative greening technologies presents a novel approach to urban greening. Based on empirical research, real-life examples of urban greening and their impact on microclimate, noise levels, and energy consumption were analyzed.* ***Results.*** *Building greening contributes to urban temperature reduction. Both vertical and horizontal greening improve air quality by reducing carbon dioxide and dust levels. Additionally, green facades and roofs enhance building energy efficiency by lowering cooling and heating costs. These solutions also help reduce noise levels in urban environments.* ***Conclusions.*** *Building and urban greening serve as essential tools for sustainable city development, combining environmental, economic, and social benefits. The implementation of modern greening technologies helps cities adapt to climate change, improve ecological conditions, and enhance residents' quality of life. Green infrastructure facilitates the harmonious integration of natural and urban solutions, creating a more balanced urban environment. Effective development of building greening requires a comprehensive approach, innovative solutions, and active municipal support.*
Key words: *building greening, urban greening, green technologies, energy efficiency, environmental sustainability, urban environment, green screens.*

СУЧАСНІ ПІДХОДИ ДО ОЗЕЛЕНЕННЯ МІСЬКОГО СЕРЕДОВИЩА

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Анотація. *У статті розглядаються сучасні підходи до озеленення будівель, їхні види та вплив на міське середовище. Окреслено екологічні переваги зелених дахів, вертикального озеленення, інте-*

грованих ландшафтних рішень та пропозицію нового методу озеленення, – усе це сприяє зниженню забруднення, покращенню мікроклімату та підвищенню енергоефективності будівель. ***Методи дослідження.*** *Завдяки порівняльному аналізу в статті зіставлені різні методи озеленення (зелені дахи, фасадне озеленення тощо) та їхні екологічні й економічні переваги. Поєднання принципів тактичного урбанізму та новітніх технологій озеленення сформувало інноваційний підхід до озеленення міста, який забезпечує гнучке та ефективне використання простору для покращення екологічної ситуації в урбанізованих зонах. На основі емпіричного методу дослідження було проаналізовано реальні приклади озеленення в містах та їхній вплив на мікроклімат, рівень шуму й енергоспоживання.* ***Результати.*** *Озеленення будівель сприяє зниженню температури в містах. Вертикальне та горизонтальне – покращують якість повітря, зменшуючи рівень вуглекислого газу та пилу. Крім того, зелені фасади та дахи підвищують енергоефективність будівель, знижуючи витрати на кондиціонування й опалення. Такі рішення також сприяють зменшенню рівня шуму в міському середовищі.* ***Висновки.*** *Озеленення будівель та міського середовища є важливим інструментом сталого розвитку міст, який поєднує екологічні, економічні та соціальні переваги. Впровадження сучасних технологій озеленення допомагає адаптувати міста до змін клімату, покращити екологічну ситуацію й підвищити комфорт життя мешканців. Зелена інфраструктура сприяє гармонійному поєднанню природних і урбаністичних рішень, створюючи більш збалансоване міське середовище. Для ефективного розвитку озеленення будівель необхідні комплексний підхід, інноваційні рішення та активна підтримка на рівні міста.*

Ключові слова: *озеленення будівель, озеленення міського середовища, зелені технології, енергоефективність, екологічна стійкість, міське середовище, зелені екрани.*

Problem Statement. Modern cities face increasing urbanization, leading to denser development, rising temperatures, air pollution, reduced green spaces, and declining quality of life for residents and visitors. Given climate change and environmental challenges, new approaches to urban space development are essential. Building and urban greening present a promising solution to mitigate the negative effects of urbanization. However, greening densely populated cities faces the challenge of limited free space. To address this issue, a new approach to greening is necessary.

Review of Recent Studies and Publications. The impact of green roofs and vertical greening on the urban environment is actively researched worldwide. In Ukraine, studies in this field are still developing, yet there are already some advancements. Researchers are exploring various aspects of vertical greening, particularly plant selection and their adaptation to urban conditions. The article «Possibilities of Vertical Greening in Urban Conditions» [1] states that climbing plants and vines are suitable for such purposes, as they effectively protect building walls from precipitation and temperature fluctuations while enhancing the city's aesthetic appeal. A study by Yu. Petrovska [2] emphasizes that vertical greening integrates natural elements into modern interiors and exteriors, saving space and improving indoor microclimates. The analysis of international green roof implementation, presented by A.A. Grechko [3], demonstrates that such structures help reduce the urban heat island effect, improve building energy efficiency, and enhance biodiversity in urban areas. The study «Green Roof Greening as a Climate Adaptation Measure in Cities» [4] examines modern roof greening technologies and their environmental impact, highlighting their role in improving microclimates and the aesthetics of urban spaces. Overall, researchers consider the implementation of vertical greening and green roofs a promising direction for urban infrastructure development, combining ecological, economic, and social benefits.

Objective of the Study. This article aims to analyze modern approaches to building greening, particularly vertical greening and green roofs, assess their impact on the urban environment, and propose a new greening approach.

Presentation of the main material. Building greening involves integrating plants into structural elements, expanding beyond traditional soil-based landscaping. The primary methods include vertical and horizontal systems, serving ecological, aesthetic, and functional roles: *green roofs* – roof surfaces planted with vegetation, contributing to moisture retention, solar heat absorption, urban heat island effect reduction, and enhanced building energy efficiency; *Acros Fukuoka* – a multifunctional complex in Fukuoka, Japan, renowned for its unique cascading green roof (pic. 1); *vertical gardens* are specialized structures that enable plant growth on building walls. They enhance thermal and sound insulation, purify the air from pollutants, and help reduce facade temperatures;

Bosco Verticale (Italian for «Vertical Forest») – two residential towers covered with trees, shrubs, and other plants, creating a unique ecosystem that purifies the air, lowers urban temperatures, and improves residents' quality of life (pic. 2);

green facades are systems with climbing plants or moss attached to building walls. They help reduce facade heating, lowering the need for air conditioning, and create a natural barrier against wind and dust; *One Central Park* (Australia) – a unique building in Sydney with green facades and integrated irrigation systems (pic. 3); *green walls* are structures where plants are integrated into a vertical surface. They are used for ecological, aesthetic, and functional urban improvements (pic. 4).

Despite significant benefits, building greening can pose certain risks affecting construction

Pic. 1. Green cascading green roof. ACROS, Fukuoka, Japan [5]

Pic. 2. Vertical gardens Bosco Verticale. Milan, Italy [6]

Pic. 3. Green facade One Central Park. Sydney, Australia [7]

Pic. 4. Green Westgate Hotel. San Diego, USA [8]

Pic. 5. Tactical urbanism. Park(ing) Day. San Francisco, USA [9]

durability and safety. *Moisture impact.* Continuous irrigation and natural precipitation can lead to moisture accumulation, fostering mold, mildew, and metal corrosion. *Root system damage*. Climbing plants can penetrate microcracks in building materials, causing gradual deterioration, which is especially dangerous for old or worn structures. *Additional load.* Biomass accumulation on facades and roofs increases structural load, potentially leading to deformation or damage. *Safety hazards.* Improper plant attachment or insufficient maintenance can cause facade elements or vegetation parts to detach, posing risks to residents and passersby. To minimize these risks, it is essential to carefully select greening systems, use high-quality mounting materials, follow technological standards, and conduct regular building inspections.

Proposal. Considering the characteristics of high-density cities, I propose applying tactical urbanism principles to urban greening, ensuring it does not disrupt the city's natural metabolism. Specifically, green screens should be implemented as a fast, efficient, and scalable solution. ***Tactical urbanism*** is an approach that enables quick, low-cost, and flexible changes in urban spaces, improving residents' quality of life. It relies on temporary or small-scale initiatives that can lead to long-term transformations. The proposed green screen technology aligns with this principle by allowing rapid, cost-effective vegetation integration into urban environments.

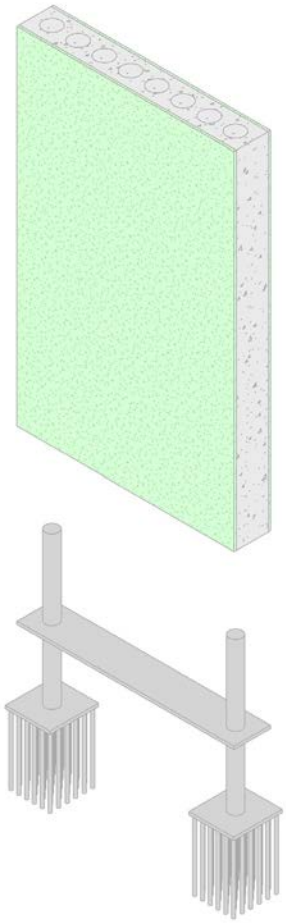
Minimal costs – using available or recycled materials. *Temporary nature* – experiments that can be modified or adapted. Community involvement – residents participate in design. Flexibility – quick responses to urban needs.

Park(ing) Day is a global initiative that began in 2005 in San Francisco when a group of designers and activists temporarily transformed parking spaces into public spaces. Since then, the event has become an international movement promoting more people-friendly urban spaces (pic. 5) [10].

Guerrilla Gardening – is a form of tactical urbanism that involves unauthorized greening of urban areas. Activists and local residents plant

Pic. 6. Guerrilla Gardening example. Cape Town, USA [10]

Pic. 7. Guerrilla Gardening example [11]



Pic. 8. Green Screen. [Author's illustration]

vegetation in neglected or unused spaces without official permission. These can include empty flower beds, roadsides, sidewalks, or even cracks in concrete surfaces. How Guerrilla Gardening Works: uses fast-growing and low-maintenance plants; conducted at night or as flash mobs; utilizes «seed bombs» – mixes of seeds and soil thrown into hard-to-reach places; Supported by local communities and activists (pic. 6).

Successful Initiatives: London – Guerrilla Gardeners have transformed hundreds of abandoned lots into blooming gardens; New York – Residents green abandoned parks and spaces between roads; Berlin – The Prinzessinnengarten initiative created an urban garden from an abandoned site (pic. 7).

Green Screen. Using modern landscaping technologies and existing structures, it is possible to create a large-scale project that can meet the greening needs of large cities around the world without interfering with the natural metabolism of the city.

Structure. The screen itself is potentially any plane that is covered with biogel, which is subsequently covered with a layer of moss. An example of a manufacturer of such biogel is Respyre. Their biogel creates a layer of special moss, in which the rhizoidal root system does not damage existing structures, but clings to their surface, like an anchor.

Endurance. Moss is quite hardy and can adapt to more severe conditions, but its reaction varies depending on the specific conditions: dry conditions: moss can survive periods of drought while dormant; when water becomes available again, it will rehydrate and resume growth; however, prolonged dry conditions can be fatal; extreme cold: moss is generally hardy and can survive at very low temperatures, including in snowy landscapes; its ability to stay dormant helps it withstand winter conditions; sun exposure: while moss prefers shady conditions, some species have adapted to withstand direct sunlight by developing protective pigments or mechanisms to retain moisture.

In general, while moss can adapt to a variety of harsh conditions, extreme conditions can limit its growth or lead to a state of dormancy as a survival strategy (pic. 8) [13].

Solution efficiency. Compactness – green screens take up minimal space, which allows them to be integrated into cities with high building density. Flexibility of application – they can be installed as a temporary solution or used for permanent greening. Passive landscaping – require minimal maintenance thanks to the use of modern technologies, including Respyre biogel. Adaptability to urban conditions – can be installed on building facades, fences, public transport supports or temporary fences. Environmental effect – they help to clean the air, reduce the urban heat island and improve the microclimate.

Implementation methods. Utilization of existing structures – green screens can be mounted on walls, fences, tram lines, bus stops, or even temporary construction fences. Implementation through modular systems – creating easily assembled frames for quick adaptation to the urban environment. Combination with the latest technologies – the use of Respyre biogel reduces the need for soil and watering, making the structure more autonomous. Pilot projects – can be initially installed in test areas, such as near schools, hospitals, or squares, to assess their effectiveness and community acceptance.

Conclusions and prospects. Greening the urban environment, in particular through green screens, is an important tool for improving the environmental situation and comfort of residents. The combination of this approach with the principles of tactical urbanism allows for a quick response to urbanization challenges, reducing the negative impact of dense development.

The proposed solution has a number of advantages: it is economically affordable, flexible in implementation, does not require significant changes in urban infrastructure, and can be integrated at different levels of the urban environment. An important success factor is the support of local communities and the use of the latest technologies, such as the Respyre biogel, which minimizes the maintenance of green screens.

Prospects for the development of this approach include its scaling up, integration into urban development strategies, and adaptation to the climate conditions of specific regions. Tactical greening will help create a harmonious, environmentally balanced and attractive urban environment for future generations.

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