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INTEGRATING GREEN INFRASTRUCTURE INTO URBAN HIGH-RISE BUILDINGS: DESIGN STRATEGIES AND BENEFITS

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Abstract

Urbanization and the increasing demand for sustainable development have led to the need for integrating green infrastructure in high-rise buildings. This article examines various green infrastructure design strategies, including green roofs, vertical gardens, green terraces, green facades, and urban agriculture. The benefits of these strategies are discussed from environmental, economic, and social perspectives. Despite the structural, maintenance, and water management challenges, solutions and best practices are presented to ensure the long-term viability of green infrastructure. The importance of building codes and regulations is also addressed. In conclusion, this article highlights the potential for architects, engineers, and urban planners to create more sustainable urban environments by incorporating green infrastructure in high-rise buildings.

Keywords: green infrastructure, high-rise buildings, sustainable development, green roofs, vertical gardens, green terraces, green facades, urban agriculture, building codes, regulations.

1. INTRODUCTION

The integration of green infrastructure in urban high-rise buildings has gained increasing attention in recent years due to the urgent need for sustainable urban development (1). As cities continue to experience rapid urbanization, they face numerous challenges, including environmental degradation, resource depletion, and reduced social well-being (2). Consequently, the incorporation of green infrastructure in high-rise buildings is emerging as a vital strategy to address these issues while promoting the well-being of urban populations and ensuring economic growth (3).

Green infrastructure refers to a network of natural and semi-natural areas that provide essential ecosystem services, such as air and water purification, climate regulation, and recreational opportunities, among others. By incorporating green infrastructure into high-rise buildings, cities can enhance their ecological resilience, improve the quality of life for residents, and contribute to the global effort to combat climate change (4). Moreover, green infrastructure can help address various urban challenges, such as heat island effects, storm water management, and biodiversity loss, thereby supporting sustainable development goals (5).

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This article aims to provide a comprehensive overview of green infrastructure design strategies for urban high-rise buildings, discussing their environmental, social, and economic benefits. We will also examine the challenges associated with implementing these strategies and explore potential solutions, including innovative materials, technologies, and design approaches. Furthermore, we will discuss the role of building codes and regulations in promoting the integration of green infrastructure in high-rise buildings, focusing on international standards and guidelines, as well as successful examples from various cities. Finally, we will conclude by summarizing the main points and offering insights into future trends and research directions in this field.

2. GREEN INFRASTRUCTURE DESIGN STRATEGIES

The incorporation of green infrastructure into urban high-rise buildings involves the implementation of various design strategies that provide multiple environmental, economic, and social benefits. In this section, we will discuss several green infrastructure design strategies, including green roofs, vertical gardens, green terraces, green facades, and urban agriculture, along with their respective advantages.

2.1 Green Roofs

Green roofs are vegetated surfaces installed on top of buildings, which can help reduce energy consumption, improve air quality, and mitigate urban heat island effects (6). They can also provide habitat for wildlife, contribute to storm water management, and enhance the aesthetic appeal of buildings (7). In addition to these environmental benefits, green roofs can offer economic advantages, such as extending the lifespan of roof membranes and increasing property values (8). Socially, green roofs can improve the well-being of residents by providing recreational spaces and promoting mental health (9).

2.2 Vertical Gardens

Vertical gardens, also known as living walls, consist of vertically mounted panels with plants grown on the exterior or interior of buildings. These gardens can improve air quality, reduce noise pollution, and provide insulation, thus contributing to energy efficiency (10). Vertical gardens can also support biodiversity, create aesthetically pleasing environments, and foster positive psychological effects for occupants (11). Additionally, they can help enhance building marketability, increase property values, and contribute to urban branding.

2.3 Green Terraces

Green terraces, or landscaped balconies, incorporate vegetation and other green infrastructure elements into terraced or stepped outdoor spaces on high-rise buildings. They offer numerous environmental benefits, including stormwater management, improved air quality, and increased urban biodiversity (12). Green terraces can also provide social benefits, such as creating communal spaces for residents, fostering social interaction, and promoting outdoor physical activity (13). Moreover, green terraces can improve the aesthetic value of buildings and contribute to higher property values.

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2.4 Green Facades

Green facades involve the use of climbing plants or trellises to cover building exteriors, helping to create a more sustainable built environment. They can provide shading, insulation, and reduce heat gain, leading to energy savings and enhanced thermal comfort (14). Green facades can also improve air quality, reduce noise pollution, and contribute to the overall aesthetics of buildings (15). Furthermore, they can provide habitat for urban wildlife and support biodiversity conservation efforts (16).

2.5 Urban Agriculture

Urban agriculture, such as rooftop gardens and vertical farming, involves the production of food within high-rise buildings or on their surrounding grounds. These practices can contribute to food security, reduce the environmental impact of food transportation, and promote the circular economy by utilizing waste streams and renewable resources (17). Urban agriculture can also provide social benefits, such as fostering community engagement, promoting healthy eating habits, and providing opportunities for education and skills development (18). Additionally, urban agriculture can generate income, increase property values, and contribute to local economic development (19).

In conclusion, integrating green infrastructure in urban high-rise buildings through various design strategies can offer significant environmental, economic, and social benefits. These strategies, including green roofs, vertical gardens, green terr aces, green facades, and urban agriculture, contribute to sustainable urban development by addressing the environmental challenges associated with urbanization, while also providing social and economic advantages. The successful implementation of these design strategies requires collaboration among architects, engineers, urban planners, and other stakeholders to ensure that the benefits are maximized and the challenges are effectively addressed. Further research is needed to explore innovative design solutions, evaluate their performance, and develop best practices for integrating green infrastructure into high-rise buildings, thereby fostering more sustainable, resilient, and livable urban environments.

3. CHALLENGES AND SOLUTIONS

Integrating green infrastructure in high-rise buildings presents a variety of challenges, such as structural, maintenance, and water management issues. However, several solutions and best practices have emerged to address these challenges, including innovative materials, technologies, and design approaches.

3.1 Structural Challenges

One of the primary structural challenges in implementing green infrastructure in high-rise buildings is the additional load on the building structure due to the weight of vegetation, soil, and water (20). This challenge is particularly pronounced in retrofitting existing buildings, where the structural system may not have been designed to accommodate the additional weight (21). Moreover, the wind resistance of green façades and vertical gardens can also affect the

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stability and integrity of the building structure (22)

To address these structural challenges, innovative materials and construction methods have been developed. For instance, lightweight growing media can reduce the weight of green roofs, green terraces, and vertical gardens, while still providing adequate support for plant growth (23). Additionally, advanced computational tools have been employed to analyze the structural impacts of green infrastructure, helping architects and engineers design high-rise buildings that can safely accommodate these features.

3.2 Maintenance Challenges

Maintenance is another significant challenge in integrating green infrastructure in high-rise buildings. The accessibility and safety concerns associated with maintaining vegetation at great heights can lead to increased maintenance costs and potential risks for maintenance personnel (24). Furthermore, the health and longevity of plants in an urban environment can be affected by factors such as air pollution, limited sunlight, and extreme temperature variations (25).

To overcome these maintenance challenges, researchers and practitioners have developed best practices and guidelines for selecting plant species that are well-adapted to the specific environmental conditions of high-rise buildings (26). Also, automated systems for irrigation, fertilization, and monitoring can reduce the need for manual maintenance while ensuring the health and performance of the green infrastructure (27). In recent case studies, innovative design strategies, such as modularity and accessibility features, have been employed to facilitate maintenance and enhance the long-term success of green infrastructure in high-rise buildings (28).

3.3 Water Management Challenges

Water management is a critical aspect of implementing green infrastructure in high-rise buildings. The demands for irrigation and the management of storm water runoff can create additional pressures on local water resources and urban drainage systems (29). Furthermore, the efficient use of water is crucial to the sustainability of green infrastructure, particularly in regions with limited water availability (30).

To address these water management challenges, innovative technologies and design approaches have been developed to optimize the use of water in green infrastructure. For example, rainwater harvesting systems can collect and store rainwater for irrigation purposes, reducing the demand for potable water (31). Additionally, research has shown that green roofs and other forms of green infrastructure can significantly reduce storm water runoff, alleviating pressure on urban drainage systems (32). As demonstrated in several recent case studies, these solutions can contribute to the overall sustainability and resilience of high-rise buildings with green infrastructure (33).

Moreover, integrating water-sensitive urban design (WSUD) principles into green infrastructure can help address water management challenges by promoting the sustainable use and management of water resources (34). For example, green roofs and terraces can be designed with specific water storage and drainage systems to prevent excess runoff and

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optimize water use (35). Additionally, the use of drought-tolerant and native plant species can reduce the need for irrigation, further contributing to the water efficiency of green infrastructure (36).

In conclusion, while integrating green infrastructure in high-rise buildings presents various challenges related to structural, maintenance, and water management aspects, innovative materials, technologies, and design approaches have been developed to address these issues. By adopting these solutions and best practices, urban planners, architects, and engineers can successfully incorporate green infrastructure into high-rise buildings, resulting in more sustainable and resilient urban environments.

4. BUILDING CODES AND REGULATIONS

The role of building codes and regulations is crucial in promoting the integration of green infrastructure in high-rise buildings. These regulations provide the necessary framework for implementing and maintaining sustainable practices in urban development. As cities around the world face the challenges of rapid urbanization, building codes and regulations are evolving to address environmental, social, and economic concerns related to urban growth (37).

International standards and guidelines play a significant role in shaping the policies and practices of green infrastructure integration in high-rise buildings. One such example is the Leadership in Energy and Environmental Design (LEED) certification system, which sets benchmarks for the design, construction, and operation of green buildings (38). LEED encourages the adoption of green infrastructure by offering different certification levels based on a building's environmental performance.

Another noteworthy initiative is the Green Building Councils' (GBCs) global network, which promotes the establishment of national green building rating systems, such as the Building Research Establishment Environmental Assessment Method (BREEAM) in the UK, and the Green Star in Australia. These rating systems foster green infrastructure integration by providing clear guidelines and incentives for developers, architects, and building owners (39).

Successful examples of cities adopting progressive building codes and regulations to support green infrastructure can be found around the world. For instance, Singapore's Green Mark scheme, launched in 2005, evaluates buildings based on their environmental impact and performance. This initiative has led to a substantial increase in the number of green buildings in the city-state (40). In 2009, Toronto became the first city in North America to require green roofs on new commercial, industrial, and residential buildings, as part of their Green Roof Bylaw. This policy has resulted in the widespread implementation of green roofs in the city, contributing to improved stormwater management, reduced urban heat island effect, and enhanced urban biodiversity (41).

Another example is San Francisco, which adopted the Better Roofs Ordinance in 2016, mandating the installation of green roofs, solar panels, or a combination of both on new buildings. This legislation aims to increase the city's renewable energy capacity and improve its resilience to climate change (42).

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In summary, building codes and regulations play a vital role in promoting green infrastructure integration in high-rise buildings. International standards, guidelines, and successful city examples provide a strong foundation for the implementation of sustainable urban development practices. As urbanization continues to challenge cities globally, it is essential to adopt and enforce progressive building codes and regulations that encourage the integration of green infrastructure, ultimately benefiting the environment, society, and the economy. By examining these international standards, guidelines, and successful examples from various cities, it becomes evident that the adoption of progressive building codes and regulations can significantly contribute to the integration of green infrastructure in high-rise buildings. As the challenges associated with urbanization continue to grow, it is crucial for policymakers and stakeholders to collaborate and develop comprehensive and enforceable building codes and regulations. These efforts will help promote sustainable urban development and ensure that green infrastructure becomes an integral part of high-rise building design and construction, ultimately benefiting the environment, society, and the economy.

5. CONCLUSION

In conclusion, this article has emphasized the importance of integrating green infrastructure in high-rise buildings for sustainable urban development. Various design strategies have been discussed, such as green roofs, vertical gardens, green terraces, green facades, and urban agriculture, as well as the environmental, economic, and social advantages associated with each approach. The structural, maintenance, and water management challenges related to implementing green infrastructure have been addressed, along with innovative materials, technologies, and design approaches that can help overcome these issues. Furthermore, this article has highlighted the critical role of building codes and regulations in promoting green infrastructure integration in high-rise buildings. International standards and guidelines, as well as successful examples from various cities, have been examined, demonstrating the potential for these practices to contribute to a more sustainable urban environment. The significance of interdisciplinary collaboration and continuous research has been underscored, as addressing the growing urbanization trends and environmental concerns requires a comprehensive understanding of the various elements involved. This article has aimed to provide a foundation for further exploration into the field of green infrastructure in high-rise buildings and sustainable urban development, offering insights that can inspire and inform future practices. By integrating green infrastructure in high-rise buildings, cities can become more sustainable and resilient, benefiting not only the environment but also the well-being of their inhabitants. Embracing these practices can contribute to creating healthier, greener, and more vibrant urban spaces for future generations.

6. FUTURE RESEARCH DIRECTIONS

Potential research areas include exploring new materials and technologies for enhancing green infrastructure performance, developing comprehensive performance evaluation tools, and investigating the impact of climate change on green infrastructure resilience. Additionally, integrating renewable energy sources within green infrastructure systems can provide valuable

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insights for sustainable urban development. Further research should also consider the socio-economic factors influencing the adoption of green infrastructure and assess the long-term benefits of these strategies in various urban contexts, with an emphasis on comparative studies between different cities and regions.

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References

1. Green Infrastructure Planning Principles: An Integrated Literature Review. Monteiro, R., Ferreira, J.C., & Antunes, P. 2020, Land ,9(12), p. 525. https://doi.org/10.3390/land9120525.
2. The Construction and Analysis of Natural Environmental Protection System Based on the Concept of Ecological Balance. Hongrong, H. 2022, Nature Environmental Protection, 3(4), pp. 60-68. https://doi.org/10.38007/NEP.2022.030407.
3. Vertical Gardens in High-Rise Buildings – Modern Form of Green Building Technology. Hanna, G.S. & Jerzy, S. s.l. : IOP Publishing Ltd, 2019. IOP Conference Series: Materials Science and Engineering, Volume 603, Issue 2. pp. 022067. DOI 10.1088/1757-899X/603/2/022067.
4. Evaluating the cooling potential of green walls and green roofs in Central European cities. Milosevic, D., Pucher, B., Savic, S., Dunjic, J., & Langergraber, G. 2023, EGU General Assembly 2023, pp. EGU23-9050. https://doi.org/10.5194/egusphere-egu23-9050.
5. Green Infrastructure Development in Urban Areas: Case Studies of Samutsakhon, Krathumbaen and Banphaeo Municipalities in Samut Sakhon Province. Nakhara. Khongouan, W., & Khamwachirapithak, P. 2021, Journal of Environmental Design and Planning, 20(3), p. 119. https://doi.org/10.54028/NJ202120119.
6. Green roofs on buildings – different view on its construction solution. Kováč. s.l. : IOP Publishing Ltd, 2022. IOP Conference Series: Materials Science and Engineering. pp. 012080. DOI 10.1088/1757-899X/1252/1/012080.
7. Composition and Diversity of Avian Communities Using a New Urban Habitat: Green Roofs. Washburn, B.E., Swearingin, R.M., & Pullins, C.K. 2016, Environmental Management, 57, pp. 1230-1239. https://doi.org/10.1007/s00267-016-0687-1.
8. Energy and Economic Evaluation of Green Roofs for Residential Buildings in Hot-Humid Climates. Mahmoud, A.S., Asif, M., Hassanain, M.A. Babsail, M.O.& Sanni-Anibire, M.O. 2017, Buildings , 7(2), p. 30. https://doi.org/10.3390/buildings7020030.
9. Social impact of green roofs. Nguyen Dang, H.A., Legg, R., Khan, A., Wilkinson, S., Ibbett, N. & Doan, A.T. 2022, Frontiers in Built Environment, 8, p. 1047335. doi: 10.3389/fbuil.2022.1047335.
10. Beyond green façades: active air-cooling vertical gardens. Davis, M.M., Vallejo Espinosa, A.L., & Ramirez, F.R. 2019, Smart and Sustainable Built Environment, 8 (3), pp. 243-252. https://doi.org/10.1108/SASBE-05-2018-0026 .
11. Vertical gardens: Manufacturing materials proposal. Oyama, L. S., Pagliarini, M. K. ., Buschieri, C. M. ., Santos, P. L. F. dos ., & Castilho, R. M. M. de. 2021, Research, Society and Development, 10(7), pp. e41510716709. https://doi.org/10.33448/rsd-v10i7.16709.
12. Vertical greenery systems: from plants to trees with self-growing interconnections. Wang, X., Gard, W.,

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/XCPH7

Borska, H., Ursem, B. & Van de Kuilen, J. W.G. 2020, European Journal of Wood and Wood Products volume, 78, pp. 1031–1043 . https://doi.org/10.1007/s00107-020-01583-0.

13. Opportunities and Benefits of Green Balconies and Terraces in Urban Conditions. Mladenović, E., Lakićević, M., Pavlović, L., Hiel, K. & Padejčev, J. 2017, Contemporary Agriculture,66(3-4), pp. 38-45. https://doi.org/10.1515/contagri-2017-0017.
14. Evaluation of Thermal Comfort Performance of a Vertical Garden on a Glazed Façade and Its Effect on Building and Urban Scale, Case Study: An Office Building in Barcelona. Bagheri Moghaddam, F., Fort Mir, J.M., Navarro Delgado, I., & Redondo Dominguez, E. 2021, Sustainability, 13(12), p. 6706. https://doi.org/10.3390/su13126706.
15. Energy Saving Aspects of Green Facades: Current Applications and Challenges. Cuce, P.M., Cuce, E, Guclu, T., & Demirci, V. 2021, Green Building & Construction Economics, 2 (2), pp. 18-44. DOI: https://doi.org/10.37256/gbce.2220211007.
16. Landscape impacts on pollinator communities in temperate systems: evidence and knowledge gaps. Senapathi, D., Goddard, M.A., Kunin, W.E. & Baldock, K.C.R. . 2017, Functional Ecology, 31(1), pp. 26-37. https://doi.org/10.1111/1365-2435.12809.
17. Flat Roofs Potentials For Implementation Of Urban Agriculture. Ljiljana, V., Danijela, M., & Magdalena, V. Subotica : UDK, 2019. 7th International conference, Contemporary achievements in civil engineering . pp. 23-24. DOI: 10.14415/konferencijaGFS2019.088.
18. Urban agriculture in the developing world: a review. Orsini, F., Kahane, R., Nono-Womdim, R.,& Gianquinto, G. . 2013, Agronomy for Sustainable Development, 33, pp. 695-72. https://doi.org/10.1007/s13593-013-0143-z.
19. Impact of Urban Agriculture on Household Income in Zambia: An Economic Analysis. Mupeta, M. ., Kuntashula, E. ., & Kalinda, T. . 2020, Asian Journal of Agriculture and Rural Development, 10(2), pp. 550–562. https://doi.org/10.18488/journal.ajard.2020.102.550.562.
20. Cost-benefit analysis for green façades and living wall systems. Perini, K., & Rosasco, P. 2016, Building and Environment, 95, pp. 110-121. DOI: 10.1016/j.buildenv.2013.08.012.
21. Base isolation retrofitting design for the existing 2-story stone building and its Conversion into a 3-Story kindergarten. Mikayel, G. M. 2023, World Journal of Advanced Engineering Technology and Sciences, 08(01), pp. 187-200. https://doi.org/10.30574/wjaets.2023.8.1.0023.
22. The city and urban heat islands: A review of strategies to mitigate adverse effects. Gago, E. J., Roldan, J., Pacheco-Torres, R., & Ordóñez, J. 2013, Renewable and Sustainable Energy Reviews, 25, pp. 749-758. https://doi.org/10.1016/j.rser.2013.05.057.
23. Application of precast foamed concrete panels for the structural deck of green roof system. Abdul, M., Muslimsyah, Mochammad, A., & Mahlil. Banda Aceh : IOP Publishing Ltd, 2019. IOP Conference Series: Materials Science and Engineering,The 9th AIC 2019 on Sciences & Engineering (9thAIC-SE). pp. 18-20. DOI 10.1088/1757-899X/796/1/012039.
24. Green maintainability assessment of high-rise vertical greenery systems . Conejos, S., Chew, M.Y.L. & Azril, F.H.B. 2019, Facilities, 37 (13/14), pp. 1008-1047. https://doi.org/10.1108/F-09-2018-0107.
25. The role of green roofs in mitigating Urban Heat Island effects in themetropolitan area of Adelaide, South Australia. Razzaghmanesh, M., Beecham, S., &Salemi, T. . 2016, Urban Forestry & Urban Greening, 15, pp. 89-102. DOI: 10.1016/j.ufug.2015.11.0130.
26. Green wall systems: A review of their characteristics. Manso, M., & Castro-Gomes, J. 2015, Renewable and Sustainable Energy Reviews, 41, pp. 863-871. DOI: 10.1016/j.rser.2014.07.203.

The Seybold Report
ISSN 1533-9211
DOI 10.17605/OSF.IO/XCPH7

27. Large-scale,rope-driven Robot for the automated maintenance of urban green facades. David, H., Christoph, M., Markus, H., & Niklas, W. s.l. : ISEC Press, 2022. Proceedings of International Structural Engineering and Construction, 9(1). pp. 12. doi: 10.14455/ISEC.2022.9(1).SUS-12 .

28. Elena, K., & Natalia, S. Modular Green Roofs in Urban Ecospace. s.l. : Intech Open, 2017.

29. System interactions of stormwater management using sustainable urban drainage systems and green infrastructure. Hoang, L., & Fenner, R. A. 2016, Urban Water Journal, 13(7), pp. 739-758. DOI: 10.1080/1573062X.2015.1036083.

30. Jemat, A.H., Kamal, N.A. Evaluation of Parameters for Sustainability Assessment of Green Infrastructure in the Urban Water System. [book auth.] H., Nor, H. A. H., Ahmad, K. A., Anizahyati, A., Muhd Norhasri, M. S., Norshariza, M.B., & Ekarizan, S. Rohana. Green Infrastructure. Singapore : Springer, 2022, pp. 263-284.

31. Green Infrastructure as an Effective Rainwater Management Approach in Cities. Maha Abdel, S.A. R. 2023, Journal of AI-Azhar University Engineering Sector, 18(66), pp. 278-303. doi: 10.21608/AUEJ.2023.283070.

32. Establishing green roof infrastructure through environmental policy instruments. Carter, T., & Fowler, L. 2016, Environmental Management, 48(1), pp. 152-164.

33. Green roofs: A critical review on the role of components, benefits, limitations and trends Author links open overlay panel. Vijayaraghavan, K. 2016, Renewable and Sustainable Energy Reviews, 57, pp. 740-752. https://doi.org/10.1016/j.rser.2015.12.119.

34. Integrated valuation of a nature- based solution for water pollution control. Highlighting hidden benefits. Liquete, C., Udias, A., Conte, G., Grizzetti, B., & Masi, F. 2016, Ecosystem Services, 22, pp. 392-401. https://doi.org/10.1016/j.ecoser.2016.09.011.

35. Green roofs as a Tool for Improvement the Stormwater Management in Urban Areas. Burszta-Adamiak, E., Janusz, L., & Pawel, W. . 2014, Jorunal of Ecological Engineering, 39, p. 47. DOI: 10.12912/2081139X.47.

36. Drought versus heat: What's the major constraint on Mediterranean green roof plants? Tadeja, S., Anna Dal, B., Veronica, L. L., Sergio, A., Mauro, T., & Andrea, N. . 2016, Science of The Total Environment, 566-567, pp. 753-760. https://doi.org/10.1016/j.scitotenv.2016.05.100.

37. Regeneration for sustainable communities? Barriers to implementing sustainable housing in urban areas . Nessa, W. 2010, Sustainable Development, 18(6), pp. 319-330. https://doi.org/10.1002/sd.399.

38. US Green Building Council. LEED v4 for Building Design and Construction. www.usgbc.org. [Online] 2016. https://www.usgbc.org/leed.

39. Analysis of Green Building Certification System for Developing G-SEED. Yosun, Y., Dongwoo, C., & Changu, C. . 2018, Future Cites and Environment, 4, p. NA. DOI: 10.5334/fce.37.

40. Governance for green urbanisation: Lessons from Singapore's green building certification scheme. Han, H. 2019, Environment and Planning C: Politics and Space, 37(1), pp. 137-156. https://doi.org/10.1177/2399654418778596 .

41. Banting, D., Doshi, H., Li, J., Missios, P., Au, A., Currie, B. A., & Verrati, M. Report on the Environmental Benefits and Costs of Green Roof Technology for the City of Toronto. s.l. : Ryerson University, 2017.

42. San Francisco Planning Department. Better Roofs Ordinance: Living Roof Manual. sf-planning.org. [Online] 2016. http://sf-planning.org/better-roofs.