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Review paper

LEGISLATIVE IMPACT ON BIOCLIMATIC ARCHITECTURE IN THE EUROPEAN UNION: CURRENT STATUS IN SERBIA

Marija Stojanović[1], Miroslav Sokić[2], Milica Mišić[3], Aleksandar Jovanović[4]

Abstract

The goal of this paper is to underscore the importance of synergizing legal norms, energy standards and urban planning strategies to advance the principles of bioclimatic architecture for its broader practical application. Contemporary climate changes and the growing imperative to preserve the environment, inevitably calls for a paradigm shift in construction and architectural practices. Bioclimatic architecture constitutes one of the key approaches in achieving energy efficiency and sustainable construction. It involves designing buildings that are intrinsically responsive to the prevailing natural environment encompassing local climate, topography and other ecological parameters in order to minimize the ecological footprint. For the successful promotion of bioclimatic principles, it must be codified within a nation's regulatory framework. The term bioclimatic architecture does not explicitly appear in legal documents, but its fundamental principles as passive solar optimization, using renewable energy sources, natural ventilation, and the adaptation of buildings to local climatic conditions are inherent in legal regulations. Therefore, particular attention will be devoted to Directives 2010/31 and 2024/1275 of the European Union, along with the statutory regulations of the Republic of Serbia, as well as the current state of bioclimatic architecture in practice.

Key words: *climate, energy efficiency, regulatory framework, European Union, Republic of Serbia, practices*

[1] M.Sc., Institute for Technology of Nuclear and Other Mineral Raw Materials, 86 Franše d'Eperea Blvd., Belgrade, email: marija.stojanovic@itnms.ac.rs, ORCID: 0009-0005-8042-2661
[2] Ph.D., Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, email: m.sokic@itnms.ac.rs, ORCID: 0000-0002-4468-9503
[3] M.Sc., Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, email: m.misic@itnms.ac.rs, ORCID: 0009-0001-8274-3136
[4] Ph.D., Institute for Technology of Nuclear and Other Mineral Raw Materials, Belgrade, email: a.jovanovic@itnms.ac.rs, ORCID: 0000-0001-9867-9282

1. INTRODUCTION

The contemporary era is increasingly defined by rapid climate change, accelerated urbanization and escalating environmental challenges, positioning architectural practice and the construction sector as pivotal domains for advancing societal sustainability. Conventional design and building methodologies typically driven by cost-efficiency and the imperative for rapid implementation are now subject to mounting pressures to undergo transformation and align with emerging ecological imperatives [1]. In this context bioclimatic architecture is a design concept aimed at utilizing natural environmental conditions to reduce energy consumption and support sustainable construction. The goal is to achieve an optimal balance between indoor comfort and ecological sustainability. Successful implementation of this approach involves the use of passive solar techniques and renewable energy sources, which contribute to minimizing negative environmental impacts [2].

This paper examines the extent to which the legislative instruments of the European Union, as well as relevant national regulations, incorporate the principles of bioclimatic architecture. Special emphasis is placed on identifying the areas that are comprehensively regulated within the legal framework, as well as those that remain insufficiently regulated. In addition to the normative analysis, the paper assesses the current state of bioclimatic architecture in practice, in order to highlight the gap between regulatory intentions and actual implementation, and accordingly proposes targeted recommendations for enhancing the legislative framework to support truly integrated bioclimatic design practices.

2. BIOCLIMATIC ARCHITECTURE - LEGISLATIVE FRAMEWORK OF THE EUROPEAN UNION

The legislative framework of bioclimatic architectural principles across the European Union is characterized by a dual structure of binding instruments and complementary non-binding measures, each contributing uniquely to the overarching goal of enhanced energy efficiency and sustainable development in the built environment.

2.1. Binding Legal Acts

The regulatory structure is primarily defined by binding legislative acts, in particular Directive 2010/31/EU, Energy Performance of Buildings Directive – EPBD [3] and Directive 2012/27/EU, Energy Efficiency Directive – EED [4]. Recognizing the differences across EU countries in factors such as the existing building stock, geography and climate, the directive allows governments to decide on some measures (*i.e.* renovation measures) best-suited to their specific national context. In order to ensure an adequate living comfort from the perspective of energy requirements, a significant amount of energy consumption is necessary. This energy demand inevitably leads to a negative ecological footprint. The importance of bioclimatic architecture lies in its ability to reduce energy use through exploitation of natural resources such as sunlight and airflow. This approach not only helps protect the environment but also enables energy savings, which is crucial for the future of sustainable housing. Given that the majority of existing residential buildings especially in this region are energy inefficient, it is imperative to implement comprehensive energy retrofitting measures to revitalize their performance and align them with contemporary

sustainability standards. Buildings are the single largest energy consumer in Europe. Also, CO_2 emissions are directly linked to energy consumption in buildings, with the impact being particularly pronounced in the residential sector. Heating and cooling of buildings is one of the largest sources of greenhouse gas emissions in Europe. The building sector is therefore crucial to achieving the EU's energy and climate goals. To boost the energy performance of buildings, the EU has established a legislative framework that includes the revised Energy Performance of Buildings Directive (EU/2024/1275) [5] and the revised Energy Efficiency Directive (EU/2023/1791) [6].

When we talk about energy standards, Directive EU/2024/1275 provides that all new buildings should be zero-emission buildings by 2030, while all new public buildings must be zero-emission from 1 January 2028 and existing buildings should be transformed into zero-emission buildings by 2050. The advent of Directive 2024/1275/EU signifies a progressive evolution in this regulatory landscape. [5]

Energy Efficiency Directive codifies a set of ambitious targets that resonate strongly with bioclimatic principles. This target sets the goal of reducing EU final energy consumption by 11.7% by 2030, compared to the projected energy use for 2030. It translates into a primary energy consumption target of 992.5 million tonnes of oil equivalent (Mtoe) and a final energy consumption target of 763 Mtoe by 2030. [6]

The latest index reveals that the EU buildings sector is significantly off track to meet its 2030 and 2050 climate goals. Final energy consumption in buildings has dropped by only 2.8%, while the target was a 6.5% reduction. The reduction is happening at less than half of the required pace. [7]

2.2. Non-binding Legal Acts

Complementing these binding directives are a range of non-binding instruments comprising guidelines, recommendations, and strategic frameworks that further articulate the rationale behind bioclimatic architecture. The most important is European Green Deal where bioclimatic architecture is promoted through several initiatives under the European Green Deal:

1. Renovation Wave Strategy: Aims to at least double the annual energy renovation rate of residential and non-residential buildings by 2030, targeting the renovation of 35 million building units. This strategy emphasizes deep energy renovations, incorporating passive design principles and renewable energy integration [8].
2. Circular Economy Action Plan: Promotes the use of sustainable materials and circular design in the construction sector, aligning with bioclimatic architecture's emphasis on resource efficiency and environmental harmony [9].

3. ENERGY EFFICIENCY IN BIOCLIMATIC ARCHITECTURE - LEGISLATIVE FRAMEWORK OF THE SERBIA

Republic of Serbia, as a candidate for EU membership is currently engaged in the harmonization of its legislation with European standards, but the principles of bioclimatic architecture are only partially regulated in the national legislative framework. The primary focus is placed on energy efficiency as most important, while broader bioclimatic aspects, as green infrastructure, the integration of water resources (rainwater harvesting and

infiltration systems), use of local and recycled materials and advanced passive systems, remain insufficiently or entirely unregulated.

Considering that bioclimatic principles play a crucial role in enhancing the energy efficiency of buildings, energy efficiency is the most comprehensively regulated aspect within the Serbian legal framework in bioclimatic fields. Its include the following legal instruments: The Law on Planning and Construction [10], The Rulebook on the Energy Efficiency of Buildings [11], The Rulebook on the Conditions, Content, The Procedure for Issuing Energy Performance Certificates for Buildings [12], and the Integrated National Energy and Climate Plan of the Republic of Serbia for the period up to 2030, with projections extending to 2050 (INECP) [13].

These instruments collectively aim to infuse sustainable principles into construction practice while aligning Serbia with the European Union's ambitious standards in energy efficiency and environmental protection. At the domestic level, the Law on Planning and Construction serves as the cornerstone of Serbia's regulatory apparatus, establishing the procedural and substantive prerequisites for urban development. This legislative act, in tandem with the Rulebook on Energy Efficiency of Buildings, emphasizes the integration of energy performance criteria into construction activities [10,11]. They stipulate that the energy performance of a building shall be determined by issuing an Energy Performance Certificate, which is issued and governed through CREP database by the Ministry for construction, traffic and infrastructure. All new buildings must obtain this certificate in order to be granted an occupancy permit and energy class of a new building, must be at least class "C" or higher. Owners of existing residential buildings are required to obtain an Energy Performance Certificate within ten years from the date this law enters into force, and the energy class must be improved by at least one level of existing buildings, following reconstruction, extension, renovation, adaptation, rehabilitation, or energy refurbishment works. [12] On the other side, INECP further reinforces this regulatory paradigm by delineating strategic goals and timelines for reducing energy consumption in buildings and incorporating innovative, energy-saving technologies. The improvement of energy efficiency constitutes a key priority. In 2022, the total energy consumption amounted to 16.4 Mtoe, and the share of households in electricity consumption was 46.17%. [9] The goal of INECP is for final energy consumption in 2030 to amount to no more than 9.6 Mtoe. [14] By signing the Sofia Declaration on the 'Green Agenda' for the Western Balkans (WB), Serbia formally acknowledged and committed to aligning with the European Green Deal, including the adaptation to local climatic attributes to enhance building performance.

The effective implementation of these standards is hampered by economic barriers inherent in the transition toward energy-efficient construction, particularly the substantial initial capital investments required for innovative technologies. Such economic impediments delay the widespread adoption of sustainable practices and, by extension, impede the transposition of robust EU norms into the domestic regulatory framework.

4. BIOCLIMATIC ARCHITECTURE – CURRENT STATUS IN SERBIA

The formal adoption of relevant statutory instruments should be followed by the effective mechanisms for integration of bioclimatic principles into practical application. The current situation in Serbia reveals a noticeable gap between regulatory intentions and actual implementation. One of the key issues is that the existing methodology for calculating and

certifying the energy performance of buildings excludes cooling load assessments, a critical omission that predisposes design outcomes toward suboptimal thermal management solutions and thereby undermines the adoption of passive cooling and natural ventilation strategies. Moreover, bioclimatic principles are neglected in the early stages of development, particularly during the urban planning phase of an area. As a result, the application of bioclimatic architecture is more common in rural than in urban areas.

Examples in rural areas are the traditional houses of Stara Planina in Senokos are largely integrated into the natural environment, incorporating significant elements and components of bioclimatic design and passive solar architecture. The traditional vernacular architecture of Stara Planina is, to a considerable extent, aligned with the principles of bioclimatic architecture [15]. Behind that, we have traditional rural houses in Vojvodina, which are largely harmonized with their natural surroundings and incorporate significant elements of bioclimatic design and passive solar architecture [16].

For Serbia to fully capitalize on the benefits of bioclimatic architecture, a multidimensional strategy is required one that aligns legislative modifications, economic incentives, and institutional capacity building with the robust models already in place within the European Union. To create a legal environment that fosters bioclimatic architecture, Serbia is required to amendment the existing legislation with:

1. Explicit definition and integration: Amend national planning and building codes to provide a clear, legally binding definition of “bioclimatic architecture.” This definition should encompass not only the principles of passive solar design, natural ventilation, and optimized thermal mass but also mandate their consideration in the permitting process. By embedding these concepts into core statutes, the regulatory framework will encourage consistency and uniformity in application;
2. Integration of bioclimatic standards into the early stages of planning, specifically the phases of urban planning and technical design, which enables the systematic implementation of measures that maximize the use of renewable/natural resources (such as solar energy, natural ventilation, building orientation, shading, etc.) with the aim of reducing the overall energy consumption of buildings.
3. Inclusion of green clauses in land lease and sale agreements;

Also, a comprehensive economic strategy is essential to overcome the initial cost barriers and foster widespread adoption, and author recommend:

1. 30% reduction in land development fees, contingent upon the implementation of bioclimatic design solutions;
2. Targeted grants for the installation of passive solar equipment, high-performance thermal insulation, and natural ventilation systems, up to 40% of the investment value;
3. Gradual introduction of a national carbon tax ranging from €20 to €50 per ton of CO_2, aligned with the EU legislative, with partial revenue recycling through subsidies for bioclimatic projects.

Establish legal frameworks that couple mandatory standards with economic incentives, as introducing accelerated depreciation, tax relief, or subsidies for new and rehabilitated projects that achieve certified bioclimatic performance levels can transform regulatory obligations into commercially viable opportunities. These mechanisms have to show that investments in energy efficiency and environmental protection generate multiple returns, and that investing in such solutions is not economically unjustified but rather part of a modern trend.

5. CONCLUSION

The analysis shows that the legislative framework of the European Union exerts a significant influence on the promotion and development of bioclimatic architecture, particularly through the progressive alignment of national regulations with the principles enshrined in the EPBD and the broader objectives of the European Green Deal.

In the Republic of Serbia, the process of transposing these directives is still ongoing. However, Serbian construction legislation is progressively aligning with European standards, with particular emphasis on reducing energy consumption and enhancing the technical quality of buildings. This evolving legal framework supports the development and adoption of technologies that improve energy efficiency in the building sector.

While Serbia's current regulations focus on optimizing energy use in construction, there remains considerable potential for further progress by integrating a wider range of bioclimatic principles. Such integration would not only help lower costs but also promote environmental sustainability more effectively. Creating a strong synergy between legal regulations and the practical measures proposed in this study is essential to establish stable conditions and incentives for their successful implementation. Moreover, incorporating bioclimatic principles in the planning of new urban developments is especially important. This includes considerations related to urban design, spatial geometry, maximizing passive solar gains, and encouraging natural ventilation. By embracing these improvements, Serbia can enhance the practical application of bioclimatic architecture, thereby making a significant contribution to Europe's energy efficiency and climate resilience goals.

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