Environmental Certification Objects Role in Architectural Design

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Abstract. The issues of ecological design of architectural objects using international (BREEM, LEED, DGNB) and national environmental standards in construction (GREEN ZOMM, SAR-SPZS) were studied. The number of certified buildings in Russia has been determined and systematized in various areas. A graphic analysis of buildings with an international environmental certificate has been carried out. The characteristic typical features of objects that meet the requirements of environmental standards regarding the arrangement of the adjacent territory, volumetric solutions, the choice of types of glazing, and the decoration of facades are highlighted. A new classification of environmentally certified buildings by architectural and compositional features is proposed: single parallelepipeds of regular shape; twin placement of volumes; volumes of a linear form; streamlined volumes; dynamic compositions with prominent elements. The main aspects for assessing the visual environmental sustainability of the objects under consideration are identified. Today, the formation of the architectural space takes place in a complex interaction of technological and environmental solutions, as evidenced by modern design experience. As part of the author’s scientific research, ways of developing further environmental certification of real estate in Russia are outlined.

1. Introduction

During the construction and operation of facilities for various purposes, a significant share of difficult renewable natural resources is consumed and a large percentage of CO2 is released into the atmosphere. With the development of environmental problems, sustainable planning of cities, districts, towns, and buildings, taking into account the requirements of environmental standards, becomes especially important [1,2].

When writing an article, the objects of research are buildings that have international environmental certificates. The subject of research is the features of certification of objects and environmentally friendly architectural space.

Ecological certification of buildings in European countries has been ongoing for several decades. The first English environmental standard, BREEM, appeared in 1990 [3]. In 1993, the LEED standard [4] was developed in America, and later in 2010 the German standard DGNB [5] was adopted. These three standards become the basic global systems of environmental certification [6,7].

In the future, each of the foreign countries adopted its own national environmental standards, taking into account local laws and climatic conditions: iiSBE (Canada); CASBEE (Japan); Green Star (Australia); HQE (France); Three Star (China) etc. [8,9].
In Canada, Australia, Japan, Hong Kong, and developed European countries, investment is envisaged for the creation of environmental certification systems based on indicators of environmental efficiency and non-environmental friendliness [10]. In other states, environmental certification for buildings is mandatory for use, for example, in the USA and Denmark [11].

Most current standards are focused on: energy consumption; reduce carbon dioxide emissions; proper waste management. The indisputable criterion for the success of the national environmental system is the number of certified projects and market demand [12].

In Russia, the first national «Green Standard» was developed in 2010. Over the past 10 years, more than ten different environmental certification systems have appeared in our country: «Corporate Olympic Green Standard»; STO NOSTROY 2.35.4-2011; STO NOSTROY 2.35.68-2012; SAR-SPZS «Low-rise construction»; SAR-SPZS «Administrative buildings»; GOST R 54964-2012 «Conformity assessment. Environmental requirements for real estate»; «GREEN ZOOM»; «Eco Village, SDS RUSO. FOOTBALL STADIOS»; ACTIVE HOUSE for new buildings and historical monuments [13,14].

Today, the RuGBC Council, together with research centers, develops all kinds of educational programs, many seminars, lectures, and training courses are held annually. Since 2019, a master's program in environmental standards has opened at NRU MGUU and five regional universities. According to a survey conducted on the site of RuGBC (Russia), the majority of respondents referred to environmental facilities as wooden construction, rather than an environmentally certified building [15].

Today, the active dissemination of «green» technologies can make a high-rise building in the city center an ecological one with a high rating in many respects, and a wooden house in the countryside with a view of the pond will not be able to obtain a certificate that does not meet modern requirements of environmental assessment systems.

In Russia, attempts to create a state national environmental standard have a very limited scope. The authors emphasize the need to recognize the requirements and regulations developed by them as partially or fully mandatory.

Meanwhile, it is reasonable practice to balance the voluntary use of «green» standards in architectural design by obtaining economic benefits [16] and state support for sustainable development.

The relevance of the study – today there is a need to study in more detail a new direction in architectural design that meets the requirements of international environmental standards in construction.

2. Review of world literature
In foreign countries, environmental design issues were studied in the works: Smif H., Cleist T. [17], Feist V. [18], La Greca P., Martinico F., Bowen WM, Park S., Elvery JA, Ajay SO, Oyedele LO, Dauda JA Geng Y., Dong HJ, Xue B., Fu J., Silva AT, Kerri AP, Piccoli R., Gonzalez MA, Doan DT, Ghaffarianhoseini A., Naismith N., Zhang TR, Ghaffarianhoseini A, Tuki J., Calvert T., Sinnett D., Smith N., Jerome G., Burgess S., King L.

In Russia, the following organizations are involved in green design and development of environmental certification systems: the Ministry of Natural Resources of Russia, RuGBC, NP SPZS, NP ABOK, NP NOSTROY, GK Ecostandard, NRU MGSU. The following researchers described questions of standardization and ecological construction in their writings: Tabunshchikov Yu.A. [19], Tetior A.N. [20,21], Krasheninnikov A.V. [22], Telichenko V.I. [23,24], Brodach M.M., Shilkin N.V. [25], Remizov A.N. [26], A. Polyakov [27], A. Benuzh [28,29].

Despite the fact that the work of many figures is devoted to the study of sustainable construction in domestic science, the current situation in the field of environmental design of architectural space in Russia indicates insufficient elaboration of a number of aspects, which, in turn, limits the application of «green» standards in the construction industry in our country.
The aim of the study is to determine the role of environmental certification objects in architectural design based on an analysis of certified buildings and further development vectors of the national environmental standard.

The task of scientific research becomes – the systematization of real estate with foreign and Russian environmental certificates, and the development of a new classification of green buildings.

The analysis of domestic and foreign literature confirmed the lack of a solution to this problem in the literature.

Based on the results of the collected material, the author uses the graphical and analytical method of research: a comparative analysis of certified buildings is carried out; studied objects are generalized into groups according to similar characteristics; the received data is systematized; a new classification of environmentally certified facilities is proposed.

3. Research results and their analysis
The number of green projects is increasing every year. But in Russia, the pace of application of environmental standards for buildings is not as high as in foreign countries, where environmental certification is stimulated at the legislative level.

Let us consider on the graph the dependence of the number of ecological buildings in our state on the year of their certification (Fig. 1).

![Graph](image)

*Figure 1. Buildings certified by environmental standards in Russia.*

The architectural space in Russia began to change in 2008 – environmentally certified projects appeared according to the English BREEAM standard (2008 – 5 objects, 2009 – 18 objects). Ducat Place III – became the first office building with high rates of energy efficiency and environmental friendliness. The peak moment for using the BREEAM system was the 2013 pre-crisis year – 24 certified buildings. Certification of real estate according to BREEAM was not stable in nature, which is clearly visible on the graph. Since 2016, the assessment of buildings under this standard has been suspended. Certification of Russian facilities according to the American LEED standard is more uniform. Buildings with LEED certification are smaller, but the certification process continues to this day (Fig. 1).

The German environmental certificate DGNB in Russia was received by only two objects in 2013.

One of the most demanded Russian standards for the current time period is the environmental standard GREEN ZOOM, introduced in 2014 by the autonomous non-profit organization Research Institute for Sustainable Development in Construction (ANO NIIURS), St. Petersburg.
GREEN ZOOM provides certification in six different areas: new construction (version 2) – NS v1.1; operated buildings; integrated sustainable development of territories for territories of complex development (from 5 buildings); universities and campuses for innovative science and technology centers; low-rise residential development; industrial operated buildings.

In Russia: 67 objects are certified according to the English BREEAM standard; 28 objects are certified according to the American LEED standard; according to the German standard DGNB, 2 buildings are certified; 54 facilities are certified according to the Russian GREEN ZOOM standard.

So, when analyzing 151 eco-friendly facilities, the author revealed a quantitative percentage of buildings in accordance with their purpose and typology (table 1).

| Certified Real Estate | Residential | Industrial | Sports |
|----------------------|-------------|------------|--------|
| by BREEAM (UK)       | 9,0%        | 21,0%      | 7,5%   |
| by LEED (USA)        | 7,2%        | 28,8%      | -      |
| by DGNB (Germany)    | -           | -          | -      |
| by GREEN ZOOM (Russia)| 71,5%       | 3,8%       | -      |

*a Note: data for April 2020.*

According to the British BREEAM standard, office and administrative (33%), trade and exhibition (25%) and industrial buildings (21%) are more widely evaluated.

According to the American LEED standard, industrial and office-administrative facilities (more than 28%) are uniformly evaluated.

According to the GREEN ZOOM standard, more often an environmental certificate is received by residential complexes (more than 70%) and offices (21%). Actively developing certification of buildings according to GREEN ZOOM in many Russian cities (Moscow, St. Petersburg, Yekaterinburg, Kazan, Arkhangelsk, Khabarovsky, Vladivostok, Irkutsk, Tyumen) makes us think about creating a new environmentally friendly architectural environment throughout Russia.

International environmental certification rules began to require architects and developers to take a new look at their projects [30].

The author has systematized 148 buildings that have international certificates BREEAM (Great Britain), LEED (USA), DGNB (Germany), iSBE (Canada), CASBEE (Japan), Green Star (Australia), HQE (France), GREEN ZOOM (Russia), SAR-SPZS (Russia). Their analysis was performed for generalization into groups on similar space-planning decisions.

The «green» objects studied by the author are distinguished by a peculiar sustainable approach to design, they use original environmental measures in contrast to the «restrained» traditional methods.

However, when analyzing the space-planning decisions of green buildings, one can meet a number of typical features and some restrictions imposed on the architecture by standards in the process of environmental certification (energy-efficient casing, energy-efficient lighting, reused materials, free planning, reduced water consumption, recycling of construction waste, automated management, security systems, etc.) (Fig. 2).

The author identified the following typical features of environmentally certified buildings (table 2).
Figure 2. Typical solutions for certified office buildings in Russia.

Table 2. Typical solutions for certified facilities.

| Architectural and compositional features of ecologically certified buildings | Offices | Residential | Trade | Industry | Sports | Education |
|-------------------------------------------------------------------------------|---------|-------------|-------|----------|--------|-----------|
| The lack of green spaces in the territory                                     | +       | +/-         | +     | +        | +      | +/-       |
| Large parking areas near the building                                         | +       | +/-         | +     | -        | -      | -         |
| Static architectural composition                                              | +       | +/-         | +     | +/-      |        | -         |
| Simple cubic volumes                                                          | +       | +/-         | +/-   | +        | -      | +/-       |
| Monotonous flat facades                                                       | +       | +/-         | +/-   | +        |        | -         |
| Simple geometric shapes with minimal use of ductile geometric ties            | +/-     | +/-         | +/-   | +        | +/-    | +/-       |
| Building transparency at night                                                | +       | -           | +/-   | -        | +      | -         |
| Hard-to-maintain panoramic stained-glass windows                               | +       | -           | +     | -        | +      | -         |
| Extended horizontal glazing tapes                                             | +       | -           | +     | +        | +      | -         |
| Rhythmic rows of rectangular openings                                         | +       | +/-         | +/-   | +        |        | +         |
| Rhythmic rows of equally repeating articulations of facades                   | +/-     | +           | +     | -        | +/-    | +/-       |
| Flat roof                                                                     | +       | +/-         | +     | +/-      | +      | +         |
| Building skeleton                                                             | +       | +/-         | +     | +/-      | +      | +/-       |
| Free open plan                                                                | +       | +/-         | +     | +        | +/-    | +/-       |
| Multi-storey building                                                          | +/-     | +/-         | +     | +        | +      | +/-       |
| Light colors in facades decoration                                            | +       | +/-         | +/-   | -        | -      | +         |

*Note: «+» – occurs; «-» – does not occur; «+/-» – is rare.*

Using architectural graphics and analytical drawings, it was revealed that volumetric compositional methods of certified structures have some similar features (table 3).

Table 3. Architectural and compositional features of certified buildings.

| Single parallelepipeds of regular shape |
|-----------------------------------------|
| BREEAM | DGNB | DGNB | CASBEE | GREEN ZOOM |
Twin placement of volumes

Linear volumes

Streamlined volumes

Dynamic compositions with prominent elements

Compared in the graph of the building are brought together by the identity of compositional solutions, the analogy in the combination of volumes, the similar nature of the division and location of the openings.

When analyzing architectural forms and space-planning features of «green» buildings, the following group patterns were identified: high-rise compact dominants with glazed planar facades; simple cubic volumes with glazed planar facades; volumetric rectangular glazing with tape glazing; separated pavilion-type volumes with flat facades; shaped volumes of curvilinear shape interacting with the medium; objects including of natural components in the volume.

To assess the visual environmental sustainability of the considered certified objects, the main aspects are identified: environmental location; reduction of the effect of the urban heat island in the territory; watering of the adjacent territory; reduction of the built-up area (structures raised above the ground, development of the underground space); compact space-planning solutions; interaction of the object with the site; the use of bionic and nature-like forms in the architectural and compositional solution; inclusion of green spaces in the architectural volume; natural materials for construction and decoration; climatic coloring of the outer surfaces of the facades; maximum use of natural light and the possibility of natural ventilation of the premises; collecting rainwater; compact space-planning solutions; use of alternative energy sources.

The first certified buildings in Russia were associated with automated, stuffed with electronics mechanisms, later examples begin to acquire a «life-sustaining» look, corresponding to the environmental aspects of architectural design and visual ecology. These are plastic space-planning decisions that interact with the environment. The role of environmental certification is particularly important in the formation of urban space. Such buildings increase the quality of the architectural environment, reduce the burden on the natural ecosystem by reducing the use of traditional forms of energy and saving resources.
Facilities using alternative energy, natural light and ventilation, rainwater harvesting and natural materials in decoration harmoniously coexist with natural components and are user-friendly. Smooth curved volume lines, buried rooms, the inclusion of green spaces in the structure of the structure, the use of a «green» roof contribute to the harmonious merger of the object with the adjacent territory. But one should be wary of the excessive technological influence of environmental standards on architecture with automation and the ability to regulate all processes in the building, which may further lead to the typification and standardization of the architectural space.

4. Findings

1. The author systematized real estate with foreign and Russian environmental certificates. The categories of objects that most often pass environmental certification in Russia are identified.

2. A new classification of eco-friendly buildings by architectural and compositional features has been developed: single parallelepipeds of regular shape; twin placement of volumes; volumes of a linear form; streamlined volumes; dynamic compositions with prominent elements.

Typological series of certified buildings are revealed: high-rise compact dominants with glazed planar facades; volumes of simple cubic form with glazed planar facades; volumes of simple rectangular shape with tape glazing; dissected volumes of the pavilion type with planar facades; plastic volumes of curvilinear shape interacting with the medium; objects with the inclusion of natural components in volume.

3. The methods of forming an environmentally friendly architectural space that meets the requirements of certification systems have been studied.

Environmental standards today are aimed at specific marketing indicators and increasing the competitiveness of construction projects in the real estate market, due to: reducing drinking water consumption; energy saving and energy-efficient shell; use of alternative energy sources; indoor climate control; management of all systems and processes.

Green standards should not only be aimed at stimulating the reduction of energy, water consumption and waste. According to the author, technogenic pressure from environmental standards in the future can negatively affect the construction of volumetric-compositional and architectural spaces.

4. The vectors of development of the national environmental standard can be:

- Separation in the national environmental standard of evaluation criteria for specialist architects (prevalence of architectural requirements) and specialists in related fields. Today, architectural and technological requirements are randomly mixed in environmental certification systems.

- Increased activities in environmental standards regarding the creation of a visually harmonious volumetric-compositional architectural look that interacts with the natural environment.

5. References

[1] La Greca P and Martinico F 2016 Energy and Spatial Planning: A Smart Integrated Approach Smart energy in the smart city: urban planning for a sustainable future. Book Series: Green Energy and Technology (Edited by: Papa R, Fistola R Springer 233 Springer Street New York NY 10013 United States) pp 43-59

[2] Bowen W M, Park S and Elvery J A 2013 Empirical Estimates of the Influence of Renewable Energy Portfolio Standards on the Green Economies of States Economic Development Quarterly vol 27 4 pp 338-51

[3] BREEAM [Online] URL: http://www.breeam.com/ (date of application: 10.04.2020)

[4] LEED [Online] URL: https://www.usgbc.org/leed (date of application: 20.04.2020)

[5] DGNB [Online] URL: https://www.dgnb.de/de/ (date of application: 15.04.2020)

[6] Abidine N Z 2010 Investigating the awareness and application of sustainable construction concept by Malaysian developers Habitat International vol 34 4 pp 421-26

[7] Atanda J and Olukoya O A 2019 Green building standards: Opportunities for Nigeria Journal of Cleaner Production vol 227 pp 366-77
[8] Geng Y, Dong H J, Xue B and Fu J 2012 An Overview of Chinese Green Building Standards Sustainable Development vol 20 3 pp 211-21
[9] Ye L, Cheng Z J, Wang Q Q, Lin H Y, Lin C Q and Liu B 2015 Developments of Green Building Standards in China Renewable Energy vol 73 pp 115-22
[10] Silva A T, Kern A P, Piccoli R and Gonzalez M A 2014 New requirements resulting from construction environmental certification programs and performance standards Arquitetura Revista vol 10 2 pp 105-14
[11] Doan D T, Ghaffarianhoseini A, Naismith N, Zhang T R, Ghaffarianhoseini A and Tuki J 2017 A critical comparison of green building rating systems Building and Environment vol 123 pp 243-60
[12] Calvert T, Sinnett D, Smith N, Jerome G, Burgess S and King L 2018 Setting the Standard for Green Infrastructure: The Need for, and Features of, a Benchmark in England Planning Practice and Research vol 33 5 pp 558-73
[13] Karpova O V 2019 Evaluation criteria for green technologies in building certification systems Regional Architecture and Construction vol 1 pp 99-104
[14] SHishov K V, Klimova E V and Dudinceva A I 2019 Implementation of «green standards» criteria in resort and recreation areas Academic Bulletin UralNIiproekt RAASN vol 2 DOI:10.25628/UNIIP.2019.41.2.003
[15] RuGBC [Online] URL: http://www.rugbc.org/ (date of application: 18.04.2020)
[16] Kiryushin P A 2019 Factors of environmentally sustainable development and the green economy in Russia Bulletin of Moscow University Series 6: Economics vol 1 pp 122-38
[17] Cleist T 2013 Materials of the training seminar on the certification system of the German Council for Sustainable Construction DGNB Consultant (Moscow Bene Rus)
[18] Feist V 2002 Passive House Design Package 2002. Passive House Quality Control Requirements 105 p [Online] URL: http://bookre.org/reader?file=747016&pg=2 (date of application: 24.04.2020)
[19] Tabunshchikov YU A 2016 Energy-efficient buildings – results achieved and prospects: Int. Congress REENCON-XXI «Renewable Energy XXI Century: Energy and Economic Efficiency»: article in the conference proceedings (Publisher: Federal State Budgetary Institution of Science Joint Institute for High Temperatures of the Russian Academy of Sciences) pp 169-170
[20] Tetior A N 2017 Cities of the future: eco-city instead of shocking environment Eurasian Union of Scientists 11-1(44) pp 12-18
[21] Tetior A N 2017 Ecozology (Moscow: RGAUMSKHA) p 167
[22] Krasheninnikov A V 2019 Urban Development of Urban Areas (Saratov: Higher education) p 113 [Online] URL: http://www.iprbookshop.ru/79620.html (date of application: 10.02.2020)
[23] Telichenko V I 2017 Green technologies of the living environment: concepts, terms, standards Bulletin of MGSU vol 4 (103) pp 364-72
[24] Telichenko V I 2018 «Green» standardization of the future – a factor of environmental safety of the living environment Industrial and civil engineering 8 pp 90-97
[25] Brodach M M and Shilikin N V 2017 From energy conservation to the construction of green buildings Int. scientific-practical conf., faculty, young scientists and students «Science, education and experimental design»: abstracts (Moscow: Moscow Architectural Institute (State Academy) p 345
[26] Remizov A N 2015 Architecture and sustainability: the complexity of relationships Housing Construction 1 pp 45-47
[27] Polyakov A 2016 Is Russia still on the sidelines? Project management 1 pp 61-63
[28] Benuzh A A and Orenburrova E N 2015 Building commissioning process according to BREEAM standard Housing construction vol 2 pp 14-16
[29] Benuzh A A and Kolchigin M A 2012 Analysis of the concept of green construction as a mechanism for ensuring the environmental safety of construction activities *Bulletin of MGSU* vol 12 pp 161-65

[30] Ajay S O, Oyedele L O and Dauda J A 2019 Dynamic relationship between embodied and operational impacts of buildings: An evaluation of sustainable design appraisal tools *World Journal of Science Technology and Sustainable Development* vol 16 2 pp 70-81