Aspects of ecological engineering as an innovative technology for architecture and construction sphere development

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Abstract. The article discusses the aspect of environmental engineering as an innovative technology for architecture and construction development of and Russia as a whole, determining directions to optimize the existing "green" standards. Innovation and greening are currently the most important trends in the development of any state economy, which cannot be achieved without the corresponding development of green certification systems aimed at ensuring sustainable growth and environmental protection. It is proved that environmental engineering issues are especially important for Russia in view of the prioritization of the innovative development vector and the actualization of the role of green innovations in architecture and construction as a prerequisite for our country to join the ranks of developed countries. Based on the evolution analysis of Russian “green” standards, factors were identified that determined the “imperfection” of their formation. Comparison of the structure and goals of existing Russian certification systems made it possible to identify their main characteristics and specifics, both contributing and leveling processes of sustainable development. Based on the research data obtained, directions for optimizing “green” standards are proposed, which implementation ensures the effective implementation of innovative environmental engineering technologies, with the latter contributing to the creation of favorable conditions for the development of the state as a whole.

1. Introduction

In today world the processes of innovative development permeate all spheres of human activity and the branches of the national economy of any country. The level of innovation activity and its complexity of individual business entities and the state as a whole directly determines the degree of national security and the situation in the "world" arena. On the other hand, currently the most important component of the state’s national security is environmental security. Greening the economy is becoming one of the priority goals for the developed countries of the modern world, determined by a reduction in the resource potential of the territories and an increase in the negative impact on the environment as limiting factors of economic growth.

As a sequence of these trends - innovative development and greening the economy - the development and implementation of innovations in environmental friendliness and environmental protection is one of the promising areas that create favorable conditions for the national economy development.

In this context issues of environmental engineering as an innovative technology aimed at ensuring sustainable development as a result of synergies of increasing the efficiency of ongoing processes while reducing harmful environmental impacts are becoming increasingly relevant. Given this trend, today
environmental engineering is widely used in various sectors of the economy. At the same time, the construction complex acquires key importance as a system of cooperation between various economic spheres, ensuring diffusion of environmental engineering technology among a complex of other sectors of the state. Confirmation of the environmental engineering special role in architecture and construction is the increase in the demand for environmental construction over the past few years. [1,2].

The most important aspect of the implementation of environmental engineering is the use of so-called “green” building standards, describing the conditions for the creation and operation of green buildings, and which are the basis for ensuring compliance with the requirements of rational development of resources and facilities construction [3,4]. The level of success of environmental engineering and the achievement of long-term sustainable development goal as a whole depends on the objectivity, completeness and ability to take into account the specifics of the green building standards application.

For Russia environmental engineering issues are extremely important. On the one hand, the innovative vector of development for our state, including in the urban development industry, is one of the priority areas as a prerequisite for the Russian economy to reach a level of growth. On the other hand, the processes of globalization and integration actualize the role of “green” innovations in architecture and construction as an indispensable condition for our country to join the ranks of developed states.

The lack of innovative development in ecology demonstrates the low proportion of introduced "environmental" innovations, making up only 1.1% in the structure of the organizations surveyed. According to official statistics, one of the reasons for the low level of environmental innovation, along with a lack of funding and an insufficient level of ecological culture, is the low level of innovative environmental technologies development, which is based on the imperfection of environmental standards that determine the impossibility of their effective application for the innovation of green building and diffusion in the national economy. At present, for Russia there is a need to form a new architectural and urban space based on the use of modern innovative technologies and meeting the requirements of environmental standards in construction [5].

Despite the fact that domestic science has of many scientists works devoted to the study of sustainable construction and various aspects of green standardization issues (for example, issues of environmentally sound design and sustainable development of the environment are considered in the works of G.N. Aidarova, E.A. Akhmedova, A.G. Bolshakova, V.I. Iovleva, A.V. Krasheninnikova, V.A. Nefedova, A.N. Tetior, O.N. Yanitsky; the role of environmental standards in architectural and urban planning was studied in the works of V.P. Knyazeva, S.B. Chistyakova; questions are standard Buildings and “green” construction were described by M.M. Brodach, Yu.A. Tabunshchikov, A.N. Remizov), the current situation in the field of environmental engineering in architectural and urban planning space in Russia indicates an insufficient study of a number of aspects, which, in turn, limits the use of green standards in the construction industry in our country [6].

In this regard, the authors set the goal of the study: to identify existing features of the building Russian environmental standards on the basis of a structured analysis, which allows to identify priority areas for their changes and improvements in order to enhance and expand the spectrum of their application to intensify the processes of innovation and environmental friendliness of architectural - urban planning space as one of the conditions for the environmental and national security of our state.

2. Review of “green” standards applying in russia and overseas

The first environmental standards for the assessment of objects appeared 30 years ago (BREEAM, Great Britain - 1990; LEED, USA - 1993) [7,8], later environmental certification systems for buildings and territories developed in different countries took the requirements of these two documents as a basis (see figure 1).

Nevertheless, taking into account the difference in “places of origin”, the certification systems being developed acquired their own characteristics and characteristic features, which were their characteristic due to the reflection of the specifics of the application environment and the key aspects that they were oriented to.
To identify the characteristic features of “green” standards, experts from different countries compared them [9].

For instance, the German scientist Dr. Peter Mosle conducted a study comparing three environmental certification systems for buildings (DGNB, LEED, BREEAM) in six assessment categories and concluded that the DGNB standard is the only system that emphasizes the economic sustainability of a building.

The European Urban Knowledge Network compares seven international standards for certification of territories (HQE-A Urban Planning and Development (France), LEED ND (USA), BREEAM Communities (Great Britain), AQUA (Brazil), DGNB Districts (Germany), Green Star Communities (Australia), CASBEE Urban Development (Japan) to identify the focus of the requirements of each of the documents. A comparative analysis showed that all standards have similar assessment categories of urban space. Some systems take more into account the quality of health and the environment, while others take great care of the economic and social quality of the project.

Comparison of LEED, BREEAM, CASBEE systems was carried out by researchers Jungwon Yoon and Jiyoung Park in their article “Comparative analysis of requirements for the use of materials in urban sustainability assessment systems: Great Britain, the USA, Japan and Korea” in order to identify indicators of the stability of materials in each system [10].

Russian researchers also compared the “green” standards in order to identify similar assessment categories, applications, identify the advantages and disadvantages of ecological systems [11].

Thus, regardless of the purpose of comparing certification systems, it was shown that the existing “green” standards differ in requirements, specifics of application, the depth of development of individual components, and focus on the scope of application.

In Russia, to date, more than ten environmental certification systems for buildings and territories have been approved and are operational.

Some environmental documents have the ability to interchange over time depending on the needs of the construction market. Other environmental standards are supplemented by new versions of various typologies of site assessment.

In order to approach the issue of identifying the specifics of domestic “green” standards, we consider the evolution of their creation and development.

3. The process of “green” standards evolution in Russia

The history of creation of Russian environmental standards began in 2008 in connection with the need to comply with sports facilities in Sochi with international environmental standards. The first Russian Green Building Councils formed in the period 2009-2010. A powerful impetus to the development of this topic was given by the environmental requirements of the International Olympic Committee for Olympic construction.
Most Russian eco-standards are based on the requirements of international systems. Three basic international commonly used certification systems were selected as the basis for national standards: BREEAM (United Kingdom, 1990); LEED (USA, 1998); DGNB (Germany, 2009) [12].

In 2009, the Green Building Council (RuGBC) was formed, which is a non-profit partnership with activities aimed at developing the latest technologies in green building in our country. RuGBC is included in the World Green Building Council (WorldGBC), the world's largest sustainable development movement.

In the year of creation, RuGBC began to actively engage in the development of domestic certification systems based on international versions, and in 2010, based on the development of the Ministry of Natural Resources, the first Russian environmental standard for the construction of sports facilities “Corporate Olympic Green Standard” appeared.

Along with the preparation of the “Olympic” standard, in 2010 an expert group of the Ministry of Natural Resources was working on its own system of voluntary environmental certification of real estate for public buildings - “Green Standards”.

Also in 2010, on the initiative of the Union of Architects of Russia, with the support of the Committee of the State Duma of the Russian Federation, the Ministry of Regional Development of the Russian Federation, the Russian Academy of Architecture and Construction Sciences, MGSU, MARCHI, a non-profit partnership “Green Building Council” (NP GBC) was created.

In 2011 the Council of NP GBC developed the first version of the eco-standard “SAR-GBC Low-rise construction” based on the partition structure of the German DGNB system and later in 2013 a new version of “SAR-GBC. Administrative buildings. Version 1.0. Voluntary certification system. Rating system for assessing environmental sustainability and habitat”.

At the same time, in 2011, IS NOSTROY 2.35.4-2011 “Green Building. Residential and public buildings. Rating system for assessing the sustainability of the environment” was developed by the non-profit partnership “ABOK”, NP NOSTROY, JSC Ts NIII Promzdaniy and NPO TERMEK LLC. In 2012, NP NOSTROY and NP ABOK introduced the state standard GOST R 54964-2012 “Conformity assessment. Environmental requirements for real estate”.

In 2014, the RuGBC Council develops and actively implements the GREEN ZOOM system “Practical recommendations for reducing energy intensity and improving the environmental friendliness of civil and industrial construction projects”.

After that work continued, and the developers of the Ecostandard group of companies, which has been successfully operating throughout Russia and the CIS since 1997, introduced new versions of Eco Village for cottage villages and Eco Pro for offices.

The increased dynamics of sports facilities construction in Russia and the requirements of the International Football Federation have identified the need to develop a version of GOST R “For Stadiums”. Environmental certification was planned for all facilities for the 2018 FIFA World Cup. In 2017, on the basis of the "Green Standard", the certification system of SDS "RUSO. FOOTBALL STADIOS."

Currently work on environmental certification systems for buildings and territories in our country, taking into account the stricter environmental requirements for environmental friendliness and innovative development, is ongoing.

Thus, based on an analysis of the evolutionary process of the origin, development and establishment of “green” certification in Russia, a number of its features are distinguished. Firstly, despite the fact that the source of the development of domestic “green” standards was the standards of leading foreign countries, the existing significant time lag of development periods abroad and in our country (30 and 10 years, respectively) determines the insufficient “maturity” of standards for Russian conditions. In other words, in “foreign countries” “green” standards had an “evolutionary” form (by analogy with the development of innovations), while our country is characterized by a “forced” form of standards development with the direct provoking influence of external factors (for example, the need to satisfy the requirements of the International Olympic Committee), while the evolutionary system was not yet ready. As a result, there were “flaws” and "bottlenecks.”
Secondly, the relatively short period of development (in respect with foreign analogues) of environmental standards also does not allow us to speak about their sufficiently thorough elaboration and the possibility of taking into account all aspects.

**Table 1.** Comparison was made of the structure and objectives of Russian standards.

| NAME OF STANDARDS | Comparison of Russian environmental standards for buildings sections |
|-------------------|-------------------------------------------------------------------|
| **Green Standards** | IS NOSTROY 2.35.4-2011 “Green construction. Residential and public buildings” GOST R 54964-2012 “Conformity assessment. Environmental requirements for real estate” SAR-GBC Administrative buildings. GREEN ZOOM GREEN ZOOM |
| **ENVIRONMENTAL ASSESSMENT SECTIONS OF RUSSIAN STANDARDS** | |
| **Pollution prevention** | Ecology of the creation, operation and disposal of the facility | Environmental management | Ecology | Ecological sustainability of the built-up area |
| **Landscaping and conservation or restoration of habitat** | Indoor comfort and environmental friendliness | Indoor comfort and environmental friendliness | Functional quality | Indoor environment ecology of buildings |
| **Reducing light pollution and the effect of local heating** | Infrastructure and environmental quality | Location and Infrastructure | Location of the built-up territory and transport support | |
| **Energy Saving and Atmosphere** | Energy Saving and Energy Efficiency | Energy Saving and Energy Efficiency | Energy efficiency and reduction of harmful emissions into the atmosphere | |
| **Regulation of storm drains and rational water use** | Rational water use and regulation of storm drains | Technical quality | Water efficiency | |
| **Waste, emissions and storage of hazardous materials** | Quality of sanitary protection and waste disposal | Quality of sanitary protection and waste disposal | Environmentally sound choice of building materials and waste management | |
| **Materials and Resources** | Life safety | Process management | |
| **Safeness** | Quality training and project management | Environmental protection during the construction, | |
Thirdly, the construction complex of our country has its own specifics of formation and development, different from foreign practice, which also imposes certain characteristic features not reflected in foreign analogues taken as a basis.

In addition, in foreign countries the focus on environmental friendliness and, accordingly, environmental engineering is, inter alia, a tool to increase competitiveness and ensure sustainable growth in the economic aspect, in our country this focusing is still absent and is, to a greater extent, a fashion trend.

Modern Russian design practice requires the mandatory implementation of the sections in accordance with Decree of the Government of the Russian Federation of February 16, 2008 No. 87 “List of measures for environmental protection” and “Measures to ensure compliance with energy efficiency requirements and requirements equipping buildings, structures and structures with metering devices for energy resources”. At the initial stage, these provisions substantially adjusted the agenda for project searches, but at present this is not enough. Recently, a number of leading design offices in the world announced the setting of ambitious goals to reach zero energy consumption of designed facilities in the coming decades. Russian architecture urgently needs qualitatively different criteria and new instruments of incentive to develop innovative solutions.

So, in order to determine the directions to optimize existing “green” standards for creating an effective basis for environmental engineering, implemented to ensure the sustainable development of architecture and construction, in particular, and the state as a whole it is necessary to identify the characteristic specific features inherent in domestic environmental standards.

4. Analysis of Russia “green” standards as the basis of ecological engineering

To analyze the existing “green” standards that underlie measures to increase the efficiency of ongoing processes while reducing environmental impact in architecture and construction, the authors used theoretical research methods to process the collected material, the structure of international environmental certification systems for buildings was studied. The sections of the environmental assessment of the documents in question were analyzed and the features and main tasks were synthesized.

Based on the study results, a comparison was made of the structure and objectives of Russian standards (see Table 1).

Based on data analysis Table 1 it seems possible to highlight a number of features characteristic for Russian green certification systems:

- each standard takes into account environmental requirements for the location and further safe functioning of the building;
- all systems pay special attention to indoor quality and comfort;
- energy conservation and water efficiency requirements are mandatory for all documents;
- "Green Standards", IS NOSTROY 2.35.4-2011, GOST R 54964-2012 and "GREEN ZOOM" contain separate section outlines measures for the collection, storage and disposal of waste;
- all documents except the “GREEN ZOOM” system pay special attention to the quality of project preparation and construction process management;
IS NOSTROY 2.35.4-2011 and GOST R 54964-2012 have the section “Quality of architecture and layout of an object” as especially important for designers.

When comparing five domestic building environmental standards, the authors identified criteria regarding ecology, technology and architecture from the general structure of their requirements (see table 2).

### Table 2. Criteria regarding ecology, technology and architecture from the general structure of their requirements.

| Russian environmental standards       | ECOLOGY | TECHNIC | ARCHITECTURAL AND URBAN PLANNING |
|---------------------------------------|---------|---------|----------------------------------|
| Green Standards                       | 23%     | 36%     | 11%                              |
| IS NOSTROY 2.35.4-2011                | 16%     | 22%     | 26%                              |
| GOST R 54964-2012                     | 21%     | 22%     | 26%                              |
| SAR-GBC                               | 21%     | 20%     | 15%                              |
| GREEN ZOOM                            | 23%     | 28%     | 11%                              |

Based on the analysis of table 2, the following conclusions can be drawn:

- the standards under consideration contain environmental and technical quality as approximately one fifth of the total system requirements;
- the Green Standards system contains more criteria regarding engineering equipment than in other documents (36%);
- all systems contain environmental recommendations on a par with the technical ones, the least environmental requirements are there in IS NOSTROY 2.35.4-2011;
- IS NOSTROY 2.35.4-2011 and GOST R 54964-2012 stand out for the largest number of architectural and urban planning points;
- the least number of architectural and urban planning requirements are there in the "GREEN ZOOM" standard;
- “Green Standards” and "GREEN ZOOM" have almost the same number of criteria regarding ecology and architectural and urban planning, which is directly related to the orientation towards the American LEED system (the American standard has always been aimed at achieving optimal energy saving indicators);
- SAR-GBC has balanced environmental and technical items, a small number of architectural and urban requirements.

In addition, the following should be noted:

1. The excessive "fixation" of Russian environmental standards developers on foreign analogues leads to duplication of the same "environmental requirements" in different certification systems.
2. In a comparative analysis of the considered environmental certification systems sections it was revealed that the environmental standards studied above contain five “mandatory” assessment categories with respect to: the ecology of the territory, location, infrastructure; the quality of the internal environment of the building, the microclimate of the premises; energy conservation, the use of renewable energy sources; water efficiency, rational consumption of drinking water; quality of sanitary protection and waste disposal.

These five basic points, presented in different wordings, can be found in almost every foreign and Russian standard. Differences of systems are in the number of certain requirements of the sections and in additional criteria regarding: economic quality of the project, innovation, quality of architecture, security of the project, etc. Environmental standards pay little attention to architectural and urban planning measures aimed at creating a high-quality environmentally friendly space in harmony with the natural environment.
Thus, today the main goal of Russian environmental standards is the environmentally friendly design, construction and further functioning of real estate due to modern engineering and technical developments and activities that contribute to: reducing drinking water consumption; increased volume energy efficiency; use of alternative energy sources; control of indoor microclimatic indicators; management of all engineering systems of the building, etc. At the same time, as the analysis showed, currently in the current systems there is insufficient attention to the issues of rational and aesthetically attractive space-planning solutions of the building. In other words, the existing certification systems for green construction do not take into account the global trend of sustainable growth based on the efficient use of resources, as well as a poorly developed orientation on the aesthetics of objects, which is one of the components of competitiveness.

5. Definition of priority directions for optimizing green construction standards as aspects of ecological engineering innovative technology development

In accordance with the results the authors suggest the following as the main vectors for the development of the national environmental standard for architectural and urban planning space, which allows for the intensification of environmental engineering processes in our country:

- a clearer gradation of architectural, environmental, engineering, organizational and economic requirements;
- making Russian environmental standards more understandable for architects and urban planners;
- an increase in the criteria for architectural physics and visual ecology;
- most proposed environmental measures should be allocated to architectural and urban requirements;
- reduce the percentage of requirements aimed at the introduction of intelligent computerized equipment;
- increase the number of criteria for constructive solutions;
- the section “Economic Quality” should be included in all Russian environmental standards.

6. Conclusion

Effective implementation of environmental engineering innovative technologies is currently impossible without the appropriate orientation of the existing “green” standards that underlie the transformations aimed at increasing resource efficiency and ensuring environmental protection. “Green” design, which is a particularly important and promising issue for the future development of the architectural and construction sector as a unifying system of elements of the national economy is one of the promising vectors of the development of the state economy. Accordingly, the need to meet the parameters of new buildings with the requirements and criteria of international environmental standards makes us think about the formation of a new architectural and planning space of our cities, environmentally friendly and resistant to external negative influences.

Implementation of the proposed directions for the development of an environmental concept consist in systematizing the criteria for assessing environmental safety at the stage of conceptual design of a building. The need for an interconnected system of criteria takes into account the stages of architectural and urban planning, headed by an architect; adoption of a comprehensive criterion for a general assessment of the architectural and planning component for a building, considering the criteria and their weight in the overall assessment, not only “brings” the current “green” standards to the requirements of the present, but also create favorable conditions for development as a sphere of architecture and construction and our state as a whole.

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