Green building as a tool of energy saving

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Abstract. The article considers main aspects of green building, energy saving criteria, international certification of LEED and BREEAM, and the legislation of the Russian Federation in this area. The analytics of enterprises and office buildings of the Russian Federation with international certificates was carried out. The reasons for the weak development of green building in Russia, especially in Siberia, have been assessed. The criteria necessary for the development of this direction are revealed.

1. Introduction
Green building is a type of construction and operation of buildings whose impact on the environment is minimal. It aims to reduce the level of consumption of energy and material resources throughout the entire life cycle of a building: from site selection to design, construction, operation, repair and demolition [1-11].

Along with high-tech solutions [13-17], the relevance of environmental projects [18-22] is indisputable.

Since Russia is replete with the mineral raw material and hydrocarbons, for a long time there has been no need for the energy-effective building. Due to this, green building in Russia is only at the stage of formation.

Since 2009, the federal law No. 261 “On Energy Saving and Improving Energy Efficiency” has been in effect, providing for a number of steps to improve the energy efficiency of buildings and structures. The energy consumption of the country's GDP by 2020 should be reduced by 40 %. Meanwhile, construction facilities use 40 % of all primary energy consumed and 67% of electricity. Studies show that over 25 % of the potential savings accounted for the energy consumption of residential and office buildings [10, 21-24].

“The fundamentals of the state policy in the field of environmental development of the Russian Federation for the period until 2030” (approved in April 2012) provide for an increase in the volume of construction of buildings and structures certified in the system of voluntary environmental certification of real estate [2].

2. Methods and materials
The following international certification systems are used in Russia: LEED (Leadership in Energy and Environmental Design, USA) and BREEAM (Building Research Establishment Environmental Assessment Method from the Construction Research Institute, UK) [3].

Some things are similar in both standards. Both of them assess the estate property from the point of view of environmental safety, energy efficiency and the introduction of modern "green" technologies
that provide a comfortable and conveniently controlled internal environment. The advantages of certificates are also similar. They are an image, a competitive advantage, raising awareness of the object in the professional community, attracting investment, energy efficiency and savings in operation, safety, quality and reliability, as well as the possibility of increasing the rental rate and improving conditions for employees or residents of the estate property.

The US Green Building Council USGBC developed the LEED standard (Leadership in Energy and Environmental Design).

BREEAM (BREEnvironmental Assessment Method) is a standard, or method, of assessing the efficiency and environmental performance of buildings, developed by the British company BREGlobal.

3. Results and discussion
Standards exist only in English: 817 pages of LEEDv4 (BD + C) and 454 pages of BREEAM International New Construction 2016. Both LEED and BREEAM regulate the creation of a quality environment, energy and water conservation, the use of regional materials, recycled materials, safe finishing materials, separate collection of waste, management of environmental and indoor parameters and other parameters, but prescribe requirements in different ways.

Both systems are intended for certification of estate properties, among which there may be a designed, reconstructed and operated building for any purpose, as well as part of a building – for example, an office or a store in which only finishing works are performed.

Both standards allow working with different functional buildings: residential, office, retail, warehouse, industrial, as well as with schools, hotels, exhibition halls and other types of estate properties [22-24].

Both LEED and BREEAM are guided by various international norms and rules: ASHRAE, ISO, EN and others.

For the certification on any of the systems it is required to pass three stages and the pay contributions for them in the currency:

Registration of a project as an aspirant to the certification.

Passing of an intermediate stage (examination of the “Project” stage, Design Review / Interim Certification).

Progress of the final examination of the constructed estate property (Construction Review/Final Certification).

The second and third steps can be unified.

Let us consider the differences between these standards.

First, by the fact that BREEAM gives the possibility to obtain intermediate certificate immediately after the design documentation is assessed, and in LEED the certificate is given only to the already constructed estate property.

In the second place, they differ by the sections of requirements. The requirements themselves are quite similar, and evaluate equivalent aspects, however, it is impossible to call them identical.

Thirdly, mandatory requirements are vital difference. There are several of them in LEED, and they are united for all levels from Certified to Platinum. Mandatory requirements are more complex in LEED than in BREEAM (for example, energy simulation) and, due to this fact, the cost of certification grows.

In BREEAM the mandatory requirements differ for the different levels of certificate – there are only several base requirements provided for Pass, and for Very Good or Excellent there are additional ones. The higher the level, the greater the requirements.

BREEAM allows you to more flexibly and freely demonstrate the requirements, it has more opportunities for a creative approach in a good sense. BREEAM-certified buildings can differ significantly. LEED is more strict and formal, more “engineering”-like.

In LEED, documentation is provided on the USGBC / GBCI online platform by filling out special forms, uploading drawings, calculations, specifications. In BREEAM, the appraiser checks all documents: he prepares an official report and sends it through his personal account to the BRE for verification with the entire documentation package.
LEED uses a transparent rating system in which points are awarded for each criterion. BREEAM is a bit more complicated: the scores obtained by category are multiplied by weightings, reflecting the significance of each of the requirements and the relevance of design solutions for the region where the estate property is located. The final rating in BREEAM is expressed as a percentage.

Texts of BREEAM standards are available on the net for free, LEED standards require paying a fee.

| LEED sections                       | BREEAM sections                       |
|-------------------------------------|---------------------------------------|
| Integration process (design complexity) | Process control                       |
| Location and transport              | Health and comfort                    |
| Construction site (building site)   | Energy                                |
| Consumptive water use efficiency    | Transport                             |
| Energy consumption and atmospheric parameters | Water |
| Consumption of materials and resources | Materials                       |
| Environmental quality indoors      | Waste disposal                        |
| Innovations in the design          | Use of the land plot                  |
|                                    | Pollution                             |

4. Important difference between standards
An important difference between standards is who can certify an estate property. In LEED, any company can register on the site, add its estate property and be certified, despite the fact that the probability of a successful outcome without experience is very small. The presence of an accredited LEED professional in the project team is an advantage and an additional point. In BREEAM, there is no choice like that, the presence of an accredited specialist - BREEAMAssessor - is mandatory. Without this specialist, the registration and certification of the project will fail [23].

Several Russian systems have been developed, including GOST R 54964–2012 “Conformity assessment. Ecological requirements for estate properties”, recognized by the state as the national standard for green building. The national standard STO NOSTROI 2.35.4–2011 “Green building” is also of great importance for the market. [4, 5].

Let us consider in more detail the criteria for energy efficiency in green building. According to the standard STO NOSTROI 2.35.4–2011 “Green building”, the category of assessment of environmental sustainability “Energy saving and energy efficiency” includes the following criteria:

- heat consumption for heating and ventilation systems;
- heat consumption for hot water system;
- electric energy consumption (for lighting, engineering systems, building air conditioning);
- electric energy consumption of energy consuming equipment and electrical products.

Special attention is paid to the category “Application of alternative and renewable energy”, where the share of secondary and renewable energy in the annual energy balance of the facility is estimated [6].

Let us consider the solution of energy saving problems by the example of construction objects certified according to LEED or BREEAM.

Freedom passive straw house, built in the Istrinsky District of the Moscow Region, requires approximately 40 kWh/m² per year for heating. This 8-10 times less than for the buildings built of brick. Energy savings are achieved here through effective thermal insulation of exterior walls, floor coverings and the roof, made of blocks of timber, filled with straw. Outside, the blocks are covered with heat-resistant wood panels, and inside - with a clay plaster on a fiber flooring. Heating is done using a wood pellet stove. In the summer, a solar collector is used to heat the water; the house is equipped with photovoltaic panels.
The SKF plant in Tver (Figure 1) is the first industrial facility in Russia to be assigned the LEED standard certification. It uses energy-efficient coolers, ventilation system with heat recovery, fans with adjustable speed, and automated control system. 75% of the building area is illuminated naturally. Due to these measures, energy savings amount up to 40% and the fan efficiency increases by 80% compared with traditional equipment.

Figure 1. The SKF plant in Tver.

Water consumption is reduced through the use of a closed-loop system and sanitary equipment with low water flow. In addition, rainwater is collected and used.

In addition, the plant sorts and recycles waste. Construction waste was used to build roads in the industrial zone, which saved money that would otherwise be used to purchase materials and transport waste to special landfills [7].

If we consider an office building, then an example is the Jones Lang LaSalle office in Moscow, which received LEED and BREEAM certificates. Energy saving is carried out here through the use of metering devices that allow one to control the energy consumption for lighting (light and motion sensors), the operation of fan coils, the heating system, which takes into account the perception of all employees.

Water is saved through the use of plumbing appliances and other devices that reduce water consumption by up to 50% compared to a regular office. Waste is collected separately and materials are reused.

CO₂ remission is reduced due to bicycle parkings. In addition, due to this, the employees keep a healthy and active lifestyle.

According to the estimates of the savings, it turned out that the payment for electricity decreased on average by 43%, while the additional costs of “greening” the office amounted to 4.8% of the project’s construction budget, and the payback period for these investments was about 6 years [8].

5. Conclusion

In conclusion, it is worth noting the factors constraining the development of green building in our country. The principles of energy-saving construction should be based on foreign experience, but always taking into account Russian specifics, especially when it comes to the implementation of projects in Siberia with its climatic features.

The current lack of awareness of broad audience of the potential of green building is also a factor hindering the development of the industry. Moreover, the main reason is, above all, Russia's being replete with cheap and affordable traditional sources of energy. There was simply no need for alternative energy. Therefore, energy-efficient construction has long developed exclusively in theory. This problem will not be solved without ideological, legal and financial support from the Government.
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References
[1] Yan Ji and Stelios Plainiotis 2006 Design for Sustainability (Beijing: China Architecture and Building Press)
[2] Gozbenko V E, Kargapoltsve S K, Karlinya Yu I, Karlinya A I and Artyunin A I 2018 Advances and Applications in Discrete Mathematics 19(3) 289-297
[3] Suslov K V, Stepanov V S and Solonina N N 2013 IEEE International Symposium on Electromagnetic Compatibility pp 841-845
[4] Stotzer M, Styczynski Z, Gronstedt P, Buchholz B M, Suslov K V and Glausinger W 2012 IEEE Power and Energy Society General Meeting 6345090
[5] “Green” standards are now in Russia, Available at: http://www.abok.ru/for_spec/articles.php?nid=5369/
[6] STO NOSTROI 2.35.4–2011 Green Building
[7] Jones Lang LaSalle Green Office, Available at: http://zvt.abok.ru/articles/104/Zelyonii_ofis_Jones_Lang_LaSalle/
[8] Ilyushkina E S and Konyukhov V Yu 2012 Bulletin of Irkutsk State Technical University 7 181-187
[9] Gozbenko V E, Kargapoltsve S K, Kornilov D N, Minaev N V and Karlinya A I 2016 International Journal of Applied Engineering Research 11(20) 10367-10373
[10] Khomenko A P, Gozbenko V E, Kargapoltsve S K, Minaev N V and Karlinya A I 2017 International Journal of Applied Engineering Research 12(23) 13773-13778
[11] Sivtsov A V, Sheshukov O Y, Tsymbalist M M, Nekrasov I V, Makhmutin A V, Egiazaryan D K and Orlov P P 2018 Russian Metallurgy (Metally) 12 1108-1113
[12] Nekrasov I V, Sheshukov O Yu, Sivtsov A V, Tsymbalist M M and Metelkin A A 2016 Steel in Translation 46(6) 435-442
[13] Sivtsov A V, Sheshukov O Y, Tsymbalist M M, Nekrasov I V and Egiazaryan D K 2015 Metallurgist 59(5-6) 380-385
[14] Gozbenko V E, Kargapoltsve S K, Kornilov D N, Minaev N V and Karlinya A I 2016 International Journal of Applied Engineering Research 11(23) 11132-11136
[15] Kargapoltsve S K, Khomenko A P, Gozbenko V E, Minaev N V and Karlinya A I 2017 International Journal of Applied Engineering Research 12(22) 12362-12368
[16] Gozbenko V E, Khomenko A P, Kargapoltsve S K, Minaev N V and Karlinya A I 2017 International Journal of Applied Engineering Research 12(22) 12369-12372
[17] Balanovsky A E, Shtayger M G, Grechneva M V, Kondratiev V V and Karlinya A I 2018 IOP Conference Series: Materials Science and Engineering 411 012012
[18] Balanovsky A E, Shtayger M G, Kondratiev V V, Huy Vu V and Karlinya A I 2018 IOP Conference Series: Materials Science and Engineering 411 012013
[19] Ivanchik N N, Balanovsky A E, Shtayger M G, Sysoev I A and Karlinya A I 2018 IOP Conference Series: Materials Science and Engineering 411 012035
[20] Balanovsky A E, Shtayger M G, Kondratiev V V, Karlinya A I and Govorkov A S 2018 Journal of Physics: Conference Series 012006
[21] Nekrasov I V, Sheshukov O Y, Sivtsov A V, Tsymbalist M M, Egiazaryan D K and Metelkin A A 2015 Metallurgist 59(3-4) 300-304
[22] Suslov K, Solonina N and Stepanov V 2015 Proceedings - 2015 International Symposium on Smart Electric Distribution Systems and Technologies, EDST 7315218 260-264
[23] Rassokhin A S, Ponomarev A N and Figovsky O L 2018 Engineering and Construction Journal 3(79) 132-139
[24] Ponomarev A N and Rassokhin A S 2016 Engineering and Construction Journal 8(68) 45-57