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Energy modeling is one of the main tasks of applying BIM

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Energy Modeling Is One of the Main Tasks of Applying BIM

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Abstract. The article reveals the essence of energy modeling of buildings, as one of the tasks of applying BIM. The topic of energy modeling technologies in construction, energy efficiency assessment and certification is discussed. Software for simulation and calculation of the power module are listed. A number of significant documents for this area is described, as well as an example of optimizing the use of energy resources and achieving maximum energy efficiency. Solutions and activities are described for the project in Yekaterinburg, Sverdlovsk region, which received a gold certificate from the Russian system for evaluating energy efficiency and environmental compatibility of designed and constructed buildings GREEN ZOOM.

INTRODUCTION

The use of information technology in the design process allows for high transparency of the process: since project data is timely added to the general model, all project participants can quickly and easily access relevant information. These technologies can reduce design costs due to competent information management and improved coordination in work. The applied software facilitates the analysis and modeling of various parameters, maintaining a number of analyzes.

Energy is the dominant factor in climate change, and it accounts for about 60% of total global greenhouse gas emissions. At the global level, the commercial and residential sectors are the second fastest growing energy sector after transport. By 2020, the number of vehicle owners is expected to increase by 32%. At the same time, it is predicted that vehicle mileage will increase by 40%. Households account for 29% of global energy consumption and, accordingly, 21% of carbon dioxide emissions resulting from their activities.

What can developers do?

Implement a set of energy saving measures, including energy-efficient lighting and equipment, efficient engineering systems. Organize infrastructure for the use of public transport, cycling and low-emission transport. Implement automation and control of energy consumption, analyze the results and use more energy-efficient solutions.

What can tenants do?

Use energy-efficient lighting and equipment. Mostly use public, bicycle and low emission vehicles. Save energy at home.

Solving Problems with BEM

The main task of applying information modeling of buildings is, first of all, to achieve comfortable living for a person. Building energy modeling (BEM) It is an integral part of the building information model and is included in the BIM Analysis section. Energy modeling methods solve the following problems for the designed building:

- development and selection of measures to improve the energy efficiency of the building;
- assessment of the return on energy saving measures;
- selection of the most suitable tariff for energy resources;
- determination of the operational cost (annual cost of energy resources) of the building.

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In addition, the use of modern methods of energy modeling allows us to estimate the length of time when the air parameters in the premises, when the design decisions are made, will not be maintained in the required range of values. A similar assessment can be carried out both for the average year and for the year with extremely high summer temperatures and extremely low winter.

Methods of energy modeling of buildings make it possible to obtain accurate values of heat input from solar radiation, including for modern buildings with a complex architectural form. This is possible due to the fact that this approach takes into account all the nuances that affect the value of heat generation: building orientation, geographic location, obscuring neighboring buildings and self-shadowing, a glazing model (including geometry and solar transmission coefficient), and most importantly, the inertia of building envelopes. [1].

Software for Modeling and Calculation of Energy Models

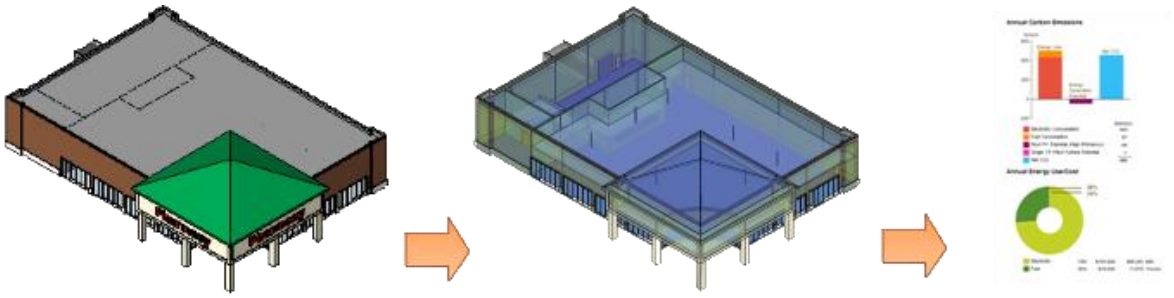

FIGURE 1. Energy analysis for autodesk revit.

Such modeling can be done using the IES Virtual Environment program. This program has a convenient user interface and features. Also, the building information model from ArchiCAD Graphisoft can be converted into an energy model using EcoDesigner Star. The model is a set of thermal blocks. As a result, architects can take full advantage of energy modeling and get accurate reports right in the ArchiCAD environment. The design process for passive buildings and facilities with reduced energy consumption has become much simpler. Autodesk Revit uses the Energy Analysis add-in to model energy consumption ‘Figure 1’. It combines Revit design capabilities with the analytic capabilities of Autodesk Green Building Studio. Green Building Studio, in turn, is Autodesk’s primary tool for performing energy simulations for the entire building. Using energy consumption modeling, you can analyze the amount of electricity supplied and consumed in all rooms and volumes of a building model.

The Multi Comfort Designer program, a product of the French corporation Saint-Gobain, also offers great opportunities for calculating the energy efficiency of a building. The program takes into account all the basic parameters of the building, such as building volume, number of floors, floor area, window and door openings (for each of the facades), rotation relative to the cardinal points, shading of structures, used components and parts, recovery systems, etc. The program has access to the Isover Multi-Comfort construction database, which facilitates the process of searching and selecting the necessary structures and assemblies. The database contains more than 200 structural details, BIM-modeling in the tasks of construction and architecture, developed by Isover specifically to achieve high standards of the Saint-Gobain multicomfort home concept. In addition, most of the details of this design have been certified by the Passive House Institute in Darmstadt (Germany).

GIS modeling has wide capabilities in the field of information storage and processing. Information is transmitted to the Geographic Information System (GIS), which provides information on energy indicators throughout the city, and also creates urban energy maps to achieve sustainable urban planning. The Irish energy company, in turn, developed a mapping tool in collaboration with the EU's Episcope project, which displays various building characteristics (for example, energy efficiency and poverty indicators for different areas) on an interactive map of Dublin. This helps to make the right decisions at the local level and to develop strategies for the development of energy efficiency of quarters. [2].

The Regulatory Framework

Achieving energy efficiency through information technology is based on the regulatory framework:

• SP 50.13330.2012 Thermal protection of buildings. [3];

• Order of the Ministry of Construction on November 17, 2017 No. 1550 / pr "On approval of the Energy Efficiency Requirements of buildings, structures, structures" [4];

• Directive 2010/31 / EU of the European Union of 05/18/2010, according to which new buildings of state institutions from 2019, other constructions from 2021, must meet high standards of energy conservation and use renewable energy [5];

• New Directive 2012/27 / EU, introducing new measures to improve energy efficiency to reduce energy consumption in the European Union by 20% by 2020 [6];

• Modernization of building engineering systems to reduce energy consumption is based on Presidential Decree No. 889 (2008) on reducing the energy intensity of the economy by at least 40% [7] and Presidential Decree No. 752 (2013) on reducing greenhouse gas emissions by at least 25% [8], which cannot be met due to the lack of energy-efficient and environmentally friendly equipment for industrial buildings in the country;

• The document of September 25, 2015, "Transforming our world: the 2030 Agenda for Sustainable Development" describes 17 global goals and 169 global goals for sustainable development [9].

The seventh goal is to ensure universal access to affordable, reliable, sustainable and modern energy for all.

Green Certification Systems

To date, the construction market in Russia presents three main systems of green certification, listed in table 1.

TABLE 1. Green certification systems.

№	System name	Country of origin	Year of foundation
1	LEED	USA	1998
2	BREEAM	United Kingdom	1990
3	GREEN ZOOM	Russia	2014

LEED (from the English Leadership in Energy and Environmental Design, leadership in energy and environmental design), BREEAM (from the English Building Research Establishment Environmental Assessment Method, an environmental assessment method for building performance) and GREEN ZOOM.

It can be difficult for developers to decide which rating system is best to choose. This is due to the variety of requirements and measures in each of them; moreover, today there is no integrated comparison between these rating systems.

This material compares three certification systems using a combined assessment method - SWOT analysis.

Through extensive academic sources and extensive practical experience, the authors collected the necessary information, analyzed it and assess the current state of certification systems in the construction market in Russia.

The results of the study will help developers find the most optimal certification system in a particular situation and avoid additional costs of time, money and effort.

For a qualitative assessment of systems, it is necessary to consider several criteria by which the evaluation will be carried out.

In our case, it is:

1. The sequence of the certification process, that is, the path from registering an object in the system to obtaining a certificate,

2. The cost of the certification process,

3. Qualification requirements for certified appraisers,

4. The main sections and categories for which the assessment is made.

The sequence of the certification process The number and sequence of steps to obtain a certificate for the systems under consideration is not the same. Some systems, such as BREEAM, have more stages of the certification process, however, an increase in the number of stages does not always mean that more time is required to obtain a certificate and / or more effort is needed to achieve the final result, each certified object is individual in this case. In general, all systems give recommendations that the certification of an object should begin at an earlier stage, for new construction this is the stage of concept selection. Moreover, to start the certification process it is necessary to have high-quality prepared and up-to-date design and working documentation.

The Engineering Bureau developed the Russian system for assessing energy efficiency in the implementation of Decrees No. 889 (2008) and No. 752 (2013) and extensively tested it in practice. This system is the most profitable in the certification process compared to peers [10].

GREEN ZOOM is a set of measures aimed at realizing development goals and improving the comfort of the urban environment. In addition, this is a list of practical recommendations for improving energy efficiency, water efficiency and environmental friendliness of facilities. The GREEN ZOOM system (table 2) is an open and flexible system, which contains the desire for self-development and self-improvement, which is driven by the power of these processes - a professional social environment.

TABLE 2. Real Estate Certification Systems GREEN ZOOM 2019.

№	1	2	3	4	5	6
Name of certification system	New construction (version 2)	Operating buildings	City or Integrated sustainable development of territories	Universities and campuses for innovative science and technology centers	Low-rise residential development	Industrial Operated Buildings

Energy Efficiency of Model

Energy efficiency of the designed building model in %, with the aim of increasing it, according to GREEN ZOOM New construction (version 2) [11] is determined by subtracting the ratio of the annual energy consumption of the designed building taking into account additional measures to the annual standard energy consumption of the base building from the standard value, multiplied by 100 percent.

Energy efficiency of a building is the percentage reduction in annual energy consumption during the operation of the designed building, using energy-saving solutions compared to the normative indicators for this building. The energy model of the building takes into account the energy consumption of the following systems and system elements: interior lighting; Outdoor Lighting; heating; air cooling; Pumps heat recovery by the cooling system; fans hot water supply; household and technological equipment; other things.

GREEN ZOOM enhances the characteristics of any development project GREEN ZOOM enhances the characteristics of any development project in six areas: the location of the built-up area; environmental friendliness of the built-up area; energy efficiency; water efficiency; environmental friendliness of building and finishing materials; environmental friendliness of the internal environment of buildings. It is also a system for assessing the energy efficiency and environmental friendliness of designed and constructed buildings. The project is scored with mandatory recommendations and requirements, and the building receives a certificate. Bronze certificate - from 35 points, silver certificate - from 45 points, gold certificate - from 55 points, platinum certificate - from 70 points. The certification body is an autonomous non-profit organization “Research Institute for Sustainable Development in Construction”.

An example of an object from Yekaterinburg

FIGURE 2. Komsomolskaya 67, Yekaterinburg, Sverdlovsk Region.

TABLE 3. Certified GREEN ZOOM objects in Yekaterinburg, Sverdlovsk Region for 2019.

Object name	Total area, m^2	Certification system	Certification stage	Energy efficiency
Residential Complex Komsomolskaya, 67	18410	HC v1.2	Project	46,21%
Residential Complex Olkhovsky Park	30003	HC v1.1	Project	33%
Business Center Palladium	22500	HC v1.1	Implementation	21%
Business Center President	26500	HC v1.1	Implementation	40%
Business Center Senate	10600	HC v1.1	Implementation	12%
Residential Complex Patrushikhinsky Ponds	17166	HC v1.0	Project	28%

The residential complex Komsomolskaya 67 on 'Figure 2' proved 46.21% energy efficiency according to the GREEN ZOOM system and received the maximum score for the event 4.5 "Optimizing the use of energy resources and achieving the maximum increase in energy efficiency" - 12 points. According to table 3, you can see that this residential complex is the most energy-efficient in Yekaterinburg in 2019.

FIGURE 3. The GREEN ZOOM Gold Certificate.

The GREEN ZOOM Gold Certificate on 'Figure 3' ensures that the quarter's design includes the most energy-efficient, water-efficient technologies, construction is carried out using environmentally friendly and certified materials, and each individual apartment will be equipped with the necessary systems to maintain a comfortable and healthy microclimate [12].

A wide range of energy-efficient solutions is being implemented at the facility:

1. Electricity

- automatic lighting control of common areas (MOS) of a residential building through a photo relay and a time relay installed in the automatic lighting control panels and short-time lighting devices (UKVO) with a time delay installed in the fixtures;

- installation of motion sensors with smooth regulation of the luminous flux of working lighting fixtures in the lobby, interroom corridors and elevator halls;

- a lighting control system for the entrances to a building that has natural light, including illumination at night and turning off the lighting at dawn;

- electric heating appliances in technical rooms with temperature sensors with shutdown when the required temperature indicators are reached.

2. Heating, ventilation and air conditioning

- heating devices are equipped with built-in thermostats;

- heat recovery of exhaust air from apartments;

- efficient air conditioning and pumping equipment.

3. Building envelope

- improved thermotechnical characteristics of enclosing and translucent structures.

The combination of a comfortable microclimate and high energy efficiency ensure the compliance of this object with both the principles of sustainable development and increased comfort for a person to stay. [10].

Vladimir Vyatkin, chief project engineer of the development company Pervostroitel: “Today we can confidently say that our understanding of comfortable living, combined with high energy efficiency and low operating costs for residents of our homes meets modern customer needs, and in the future these solutions will only be improve.

As a confirmation of our intentions, the company is developing and introducing a new construction standard based on the results of microdistrict. Komsosmolskaya 67. This is a requirement of time and new consumers living in the 21st century: living should be as comfortable as possible with minimal maintenance, and that is why we are looking for new technologies, we are developing various models and combinations of these technologies for our projects. The next project, Prospect Mira Compound already includes all the positive developments in the solutions, and we are ready to add a number of innovations to it. "

CONCLUSION

Using the example of a construction site in Yekaterinburg, one can be convinced that the use of BIM technologies makes it possible to achieve the optimal use of energy resources, as well as to achieve sustainable development goals and increase the living conditions of a person.

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