Business center construction project as the model of resource-saving building

V V Luchkina

1 Moscow State University of Civil Engineering, 26, Yaroslavskoye shosse, 129337, Moscow, Russia
E-mail: luchkinavv@mail.ru

Abstract. Design with resource-saving technologies has become an important part of the Terms of Reference for the project, and environmental friendliness has become a key core of the business center marketing strategy. The purpose of research was to develop the business center construction project as the model of resource-saving building. The research results are the following tasks: to create the comfortable environment for lessees and guests: thermal and visual comfort, air exchange quality; to ensure high energy efficiency of the building; to reduce the resource consumption costs to maximum (energy, water and heat). In the research, the project concept and business plan were developed, the project risks analysis was conducted and the project economic efficiency assessment was performed. In the course of research, the calculations of the full life cycle cost of the building were analyzed and made. The following technical characteristics on internal and external lighting, heat supply of the building, comfortable environment, heat exchange quality, water treatment and re-use, and energy-efficient elevators were considered. The project comprises the land improvement plan for adjacent territory, including introduction of the “green” roof technology into operation. In the project, the risk of excess water consumption and damage of finishing materials and equipment were brought to minimum. It is planned to have separate accounting of the energy, water and heat by various lessees, floors and functional areas of the business center. The readings will be recorded by the automated control and dispatch system of the building. This will make it possible to conduct a detail results analysis, keep statistics and set the goals to reduce the resource consumption.

1. Introduction
Operation and construction of any building are related to the required power consumption for heating, ventilation, water heating, lighting and supply of various household appliances and tools. We use the energy in the form of heat and heat carrier media: gas, liquid fuel and power energy. The payment for energy constitutes the main part of the building maintenance costs, and this part of the costs constantly tends to price increase. The payment depends on the energy consumption, and the consumption can be low if the building is designed and constructed according to the energy-saving rules [1].

Having studied the development of the office services market in Moscow, the researched decided to create a project of the office business center for the purposes of commercial profit from rent. Design with resource-saving technologies has become an important part of the Terms of Reference for the project. And environmental friendliness has become a key core of the business center marketing strategy: the name, logo, facade and entry elements finish - all these should remind future users of the
green principles of construction and control of the building [2]. The project stands out in the part of perception of the environmental friendliness as a key element of the market positioning.

The purpose of research was to develop the business center construction project as the model of resource-saving building. On the basis of the expert assessment, the extra costs arising from the construction budget increase due to certification were calculated. The exceedance of the base construction budget in the implementation of the solutions prescribed by the green standard makes about 16% (approx. 200 USD/ sq.m of the building area). And 10% of extra costs (that is 20 USD/ sq.m) will be made of additional surveys and consulting.

The research results are the following tasks:

- to create the comfortable environment for lessees and guests: thermal and visual comfort, air exchange quality;
- to ensure high energy efficiency of the building;
- to reduce the resource consumption costs to maximum (energy, water and heat).

2. Materials and Methods
To meet the consumer demand among population and guests of the city at the highest level, the project provides for creation of the office center of A-Class. The building consists of two linked rectangular blocks of different height. Block “A” is a 22-storeyed tower office building with a spacious double-height lobby, cafe, bank department and guard. Block “B” is a 5-storeyed functional part with a hotel for 40 room and fitness club. The adjacent territory will include a surface car parking, underroof bicycle parking and electric vehicle charging station, as well as relax and recreation area for the building users and local residents. The business center is supposed to be located within walking distance of the metro station and public transport stops.

The terms of reference were developed considering the BREEAM requirements and other international practices and standards. EN12464-2011 was used to make a visual environment, and GOST R EN 13799 to describe the internal air quality.

In the research, the project concept (decomposition) and business plan were developed, the project risks analysis was conducted and the project economic efficiency assessment was performed [3].

3. Discussion
In the course of research, the calculations of the full life cycle cost of the building were analyzed and made. The following technical characteristics on internal and external lighting, heat supply of the building, comfortable environment, heat exchange quality, water treatment and re-use, and energy-efficient elevators were considered. The project comprises the land improvement plan for adjacent territory, including introduction of the “green” roof technology to into operation [4].

The increased focus of the design is on the comfortable environment for lessees: thermal and visual comfort, air exchange quality. The argon filled insulating glass units were chosen to ensure combination of these two requirements.

The internal lighting of public areas will be provided by energy-efficient LEDs. The control is provided by the motion ad illumination sensors. In the daytime, the artificial illumination of the staircase in the places with daylight illumination is automatically switched off.

In the course of the concept development, the calculations of the full life cycle cost of the building were made. The operating expenses (utility fees, maintenance and repair, administrative management) are expected to make 80% of the full life cycle cost of the building. The utility fees will make only 10% of the project costs that greatly differs from similar projects abroad with 30-40% accounted for this indicator [5].

It is planned to use the energy-efficient elevators KONE with recuperation system, elevator cab LED lighting, and deactivation of various functions in standby to save energy. When the elevator lifts up with the cab not fully loaded or down heavy loaded, it generates the energy to be re-used for its
operation and other purposes. Such solution provides for reduction of the consumed power energy of the elevators by 20-35% depending on the building height [6].

The heat supply of the building is provided by own boiler facility. This makes it possible to maintain the conform temperature irrespective of the urban network. All the equipment of the individual heat supply facility have the 100% redundancy that, in addition to ensuring the reliable operation, provides for maintenance without complete switch-off. When choosing the boiler equipment, a special attention was paid to minimization of the NOx emissions and maximum efficiency.

The three-way water boilers Vitomax by Viessmann were chosen in combination with the gas burners Weishaupt, version 3LN, with Multiflam technology [7].

The heat comfort modeling proved the efficiency of the adopted temperature zoning strategy. The thermostatic heads on all heaters will provide for regulating the heating capacity of each heat device and changing the temperature parameters in the near-window zones. The project provides for individual control of each fancoil using the remote control. To ensure comfort temperature inside both on hot summer days and in the period between seasons, the fancoils work in air cooling and heating [8].

The external illumination is controlled by the illumination sensors and according to the schedule using the dispatch system of the building. The lights are arranged so that to bring the light pollution to minimum at night and keep out stray light to the windows of the neighboring residential houses. At night, all the external illumination is of secondary importance, and the architectural and decorative illumination is fully switched off [9].

In the project, the risk of excess water consumption and damage of finishing materials and equipment were brought to minimum. The total water consumption in the business center is supposed to be reduced by 55% as compared to the basic level [10].

The territory of the surface multilayered parking of the business center for 400 cars includes the designed car wash with the water treatment and recirculation system. The contaminated water discharge to the urban water disposal system is completely excluded. The oil separators are provided as in case of the fire system actuation in winter and during floor cleaning, there is a risk of the contaminated water ingress into the sewerage. To avoid the dirt ingress into the urban run-off water system, the project provides for using the 5-degree run-off treatment facilities [11].

The detailed plan of the adjacent territory improvement provides for tree and plants setting. An extensive green roofing is supposed to arrange on the building. The rain water collected from the roof into a special underground tank will be used for watering. There are the water-saving plumbing fixtures in the building: double drain in the toilet tanks, waterless urinals, mixers, shower heads, washing and dish-washing machines with low water consumption [12].

To prevent water leakage in case of the equipment failure, each WC facility is provided with the valves controlled by the motion sensors. They cut off water supply when there are no people in the facility. Also, the building is provided with special equipment to trace the water consumption by duration using the dispatch system. This provides for quick detection of the main water pipeline failure or localize minor leakage [13-15].

4. Conclusions

It is planned to have separate accounting of the energy, water and heat by various lessees, floors and functional areas of the business center. The readings will be recorded by the automated control and dispatch system of the building. This will make it possible to conduct a detail results analysis, keep statistics and set the goals to reduce the resource consumption. The conditions for separated waste collection are created in the building. There is a designated area for several containers for each waste group. Also, a waste compactor will be installed to increase the container filled density (by 5-7 times more than in the normal storage) and reduce the frequency of the waste removal for further processing.

Data on resource saving potential for the business center construction project are summarized in Table 1.
In the course of research, the economic effect of the business center construction project was assessed. With the factored level of incomes and expenses, the project can be recognized efficient. The financial plan is executed for the 10-year prospect. The investment idea under consideration is characterized by the following indicators:

- the first payback period of the total investment costs without taking into account the construction period makes about 6.30 years;
- the discounted payback period taking into account the effective percentage rate of 10% per annum makes about 10.4 years from the start of the project implementation.

**Table 1.** Data on resource saving potential of the construction project.

| The spent resource      | Technical solution                                                                 | Resource-saving potential                  |
|-------------------------|------------------------------------------------------------------------------------|---------------------------------------------|
| System of a power       | Dispatching system (Energy-efficient lamps, Energy-efficient elevators KONE)       | Reduce electricity consumption per 20-35%   |
| consumption             | Dispatching system (the three-way water boilers Vitomax by Viessmann were chosen  |                                             |
|                         | with the gas burners Weishaupt, version 3LN, with Multiflam technology)           |                                             |
| Heat supply             | Double-glazed windows filled with argon; thermostatic heads on heating radiators,  | All equipment has 100% redundancy          |
|                         | fencoyles 90% of all rooms                                                         |                                             |
| Thermal comfort         | Dispatching system (valves in bathrooms; car wash water treatment and reuse        | 90% of all rooms                           |
|                         | system)                                                                             |                                             |
| System of water         | Landscaping, green roof technology                                                  | Decrease by 55%                            |
| consumption             |                                                                                   |                                             |
| Visual comfort          |                                                                                   | Air pollution reduction                     |

When calculating this business plan, the option was applied to increase the value of rental rates by 10% every two years, starting in 2024. Thus, the value of the revenue part per quarter, taking into account 5% losses by year of the project, will be (Table 2):

**Table 2.** Planned revenues from the project.

| Year of the project | Rental fee, $ USA |
|---------------------|-------------------|
| 2024                | 823 415.79        |
| 2025                | 823 415.79        |
| 2026                | 905 490.51        |
| 2027                | 905 490.51        |
| 2028                | 996 039.56        |
| 2029                | 996 039.56        |
| 2030                | 1 095 643.51      |
| 2031                | 1 095 643.51      |

In the course of research on the project management, the risk was studied and analyzed and found out the weaknesses of the project production implementation, such as:

- changes in the Russian legislation affecting the office premises lease;
- increased construction periods due to overdue receipt of investments;
raised cost of construction materials and works in the course of construction.

An example of the successful business center project put into operation is the BC Greendale project that, in 2014, took the second place in the Russian ecodevelopment contest Green Awards. In summer 2015, the Greendale project has got the first in Russia BREEAM certificate with the highest possible rating: Outstanding.

Project characteristics: purpose of the building - A-Class business center, Customer - O1 Properties, General Desighner - Spectrum Group, architects - APA Wojciechowski Architekci, area of the building: total area – 55,500 sq.m, lease area – 34,000 sq.m, location: 98 Oktyabrskaya Str., Moscow (Maryina Roshcha), construction completion period: Q2 2016. The project provides for implementation of the advanced technologies: “green” roofing, ventilation system with re-recuperation, energy-saving glasses with improved transparency. The energy modeling performed with special software using the ASHRAE 90.1–2010 methodology showed that the total energy consumption of the building would be by 36.5% lower than the basic option. This result was achieved due to the high quality of the enclosure structures and careful selection of engineering utilities. According to the JLL press-release, the percentage of scores gain in certification made 88.5%. Such rating is currently the highest and the sole one in Russia.

Various resources are required for the building operation. The building can be considered as a flow-through system. The further topics to research can be the more detailed study of the incoming and outcoming flows (energy, ventilation, emissions, heat, sewerage, water) and opportunities of their reduction providing for creation of the resource-saving buildings.

References
[1] Luchkina V V 2018 Optimization of the project of energy efficient construction and the analysis of the market of energy efficient technologies at design of buildings System technologies 28 pp 5-12
[2] Luchkina V V 2019 Analysis of application of ”green” roof technologies as objects of improvement Prospects of science 12(123) pp 147-150
[3] Luchkina V V 2017 IOP Conf. Series: Earth and Environmental Science Vol 90 pp 1-6
[4] Luchkina V 2019 Materials Science Forum Vol 945 pp 1043-1046
[5] Usanova, K., Vatin, N. University BIM distance learning course for secondary school students, (2017) Advances and Trends in Engineering Sciences and Technologies II - Proceedings of the 2nd International Conference on Engineering Sciences and Technologies, ESaT 2016, pp. 297-302.
[6] Vatin, N.I., Usanova, K.Y. BIM end-to-end training: From school to graduate school, (2019) Advances and Trends in Engineering Sciences and Technologies III- Proceedings of the 3rd International Conference on Engineering Sciences and Technologies, ESaT 2018, pp. 651-656.
[7] Luchkina V 2019 E3s Web of Conferences 97 Vol 97 01037
[8] Luchkina V 2019 E3s Web Conf, Vol 110 01083
[9] Sinenko S, Poznakhrko T 2018 MATEC Web of Conferences 193 05011
[10] Sinenko S, Poznakhrko T, Obodnikov V 2019 MATEC Web of Conferences 270 05008
[11] Kazaryan R 2018 MATEC Web of Conferences Vol 193 02023
[12] Kazaryan R 2018 IOP Conf. Series: Materials Science and Engineering 463 022089
[13] Kazaryan R 2018 MATEC Web of Conferences Vol 196 04030
[14] Kazaryan R, Belyaev K 2019 E3S Web of Conferences, FORM-2019 Vol 97 04002
[15] Kazaryan R, Pogodin D 2019 E3S Web of Conferences, FORM-2019 Vol 97 04002