Modern energy efficient technologies of high-rise construction

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Abstract. The paper analyzes modern energy-efficient technologies, both being applied, and only introduced into the application in the construction of high-rise residential buildings. All technologies are systematized by the authors as part of a unified model of "Arrows of Energy-Efficient Technologies", which imply performing energy-saving measures in the design, construction and operation of buildings.

1 Introduction

In conditions of legislative introduction of new standards in the field of energy efficiency of multi-apartment buildings under construction (hereinafter referred to as MAB), one of the important criteria in the field of high-rise construction is the use of modern energy-efficient materials, equipment and technologies in construction of new buildings. The development of appropriate regulations and rules has allowed to establish the necessary legislative base [1-4].

2 Methods

In accordance with the developed documents, a growing number of construction companies are using more energy-efficient solutions. One of the reasons for this attention to the level of energy efficiency of MAB is their prevailing role in the total energy consumption of the entire urban economy shown by the example of Moscow in the following diagram (Fig. 1) [5].

In accordance with the foregoing, it can be concluded that energy-efficient construction in the housing sector is one of the promising areas of high-rise construction. In practice, it is aimed not only at achieving compliance of buildings under construction with legislative norms, but also at increasing demand for such real estate from buyers. Certain attention is paid in the domestic science to the studies in the field of energy saving technologies in housing and communal services, but, as practice shows, existing developments, unfortunately, are not of a systemic nature and are devoted to selective analysis of certain energy-efficient technologies.

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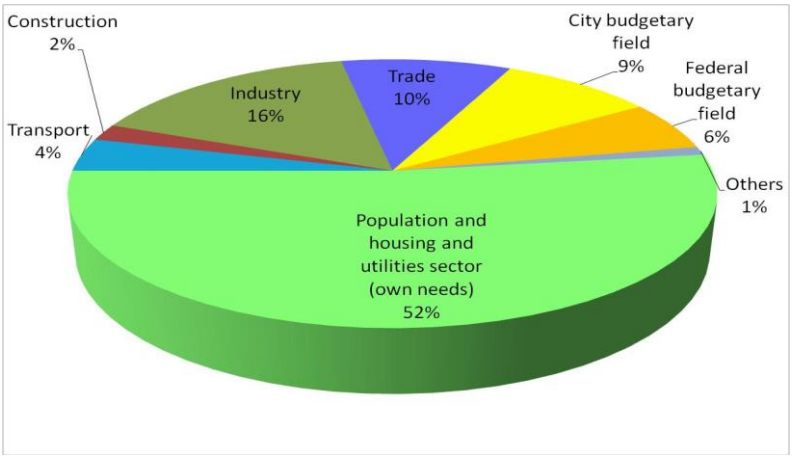

Fig. 1. Distribution of energy consumption in Moscow.

As part of the study, the authors developed a unified model called the "Arrow of Energy-Efficient Technologies", which combines energy-saving technologies implemented in all structural and engineering subsystems of MAB, as well as those solutions that should be applied at the building design stage in order to pre-select and analyze individual technologies and options for their integration into a single project. Systematicity in the issue of selecting and implementing energy-efficient technologies, according to the authors, is one of the most important factors for success in MAB construction. Visual representation of the proposed model is shown in the diagram (Fig. 2).

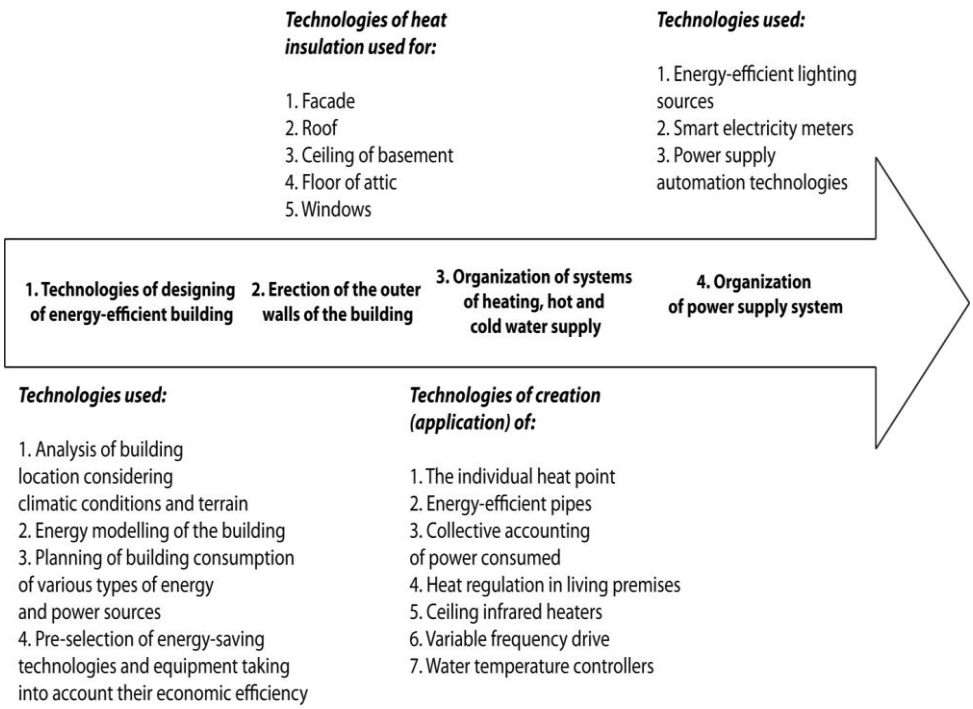

Fig. 2. the "Arrow of Energy-Efficient Technologies".

The model developed by the authors is based on previous studies in the field of energy saving in the form of three components: for training of personnel (a complex educational model of the "Arrow of Energy-Efficient Competencies" was developed [6]); as part of developing a unified approach to automation of energy saving processes (the foundations of an integrated information and analytical system that implements all the functions of energy-efficiency management of buildings based on data from metering devices were formulated, while developing a methodical approach to improving energy efficiency, recommended for use in various industries [7].

3 Results

The implemented system has become one of the most popular and successful in the Russian market, allowing to analyze the energy efficiency of heating subsystems, hot and cold water supply, power supply subsystems in automatic mode, calculating the current level of energy consumption, detecting violations of qualitative and quantitative parameters of energy resources received by the building, managing its energy installations, and issuing recommendations on the introduction of additional energy-saving technologies.

Let's consider separate, most significant components of the mentioned blocks of the "Arrow of Energy-Efficient Technologies". Within the first block, when analyzing the building location, taking into account climatic conditions and terrain, it is also necessary to take into account the environmental requirements for MAB construction [8].

The software complexes used for energy modeling allow forming, calculating and analyzing heat, lighting and aerodynamic processes: heat exchange between the facade of the building and the external environment, heating loads, heat generation, etc. The most popular software systems in the field of energy modeling include DOE 2.2, Equest, Trane TRACE 700, Carrier HAP, which are widely used in Europe and the US and have enough modules to calculate various energy and engineering parameters of the buildings under construction.

The Project Expert software package proved to be suitable to pre-select energy-efficient technologies and equipment with the calculation of their economic efficiency.

In the second block, the most important role is played by the technology of thermal insulation of the building facade, since it is through the walls that the building loses up to 40% of heat. Energy-efficient technologies in this area are: a suspended ventilated facade that contributes to the building's strength and provides excellent thermal insulation, fire safety, protecting the walls from negative weather effects, liquid ceramic insulants (TSM KERAMIK), providing energy-saving effect 10 times higher than traditional materials, and extruded polystyrene foam.

One of the promising directions in the development of insulation for roofing is the technology of incorporating natural components into mineral wool insulation materials, which ensure a higher level of their environmental compatibility and safety, for example, the incombustible insulation Ekos developed by Knauf. For the insulation of the ceiling of basement - extruded polystyrene foam, as well as sprayed insulation materials from polyurethane foam Ecotermix Bio produced by the Russian company Ecotermix.

When insulating the floor of attic, it is advisable to use reflective insulation materials: penofol, armofol, liquid foil, etc., which can reduce the thermal conductivity of insulation materials up to 10 times.

Currently, there are several types of energy-saving double-glazed windows. A type of such products quite common in the market is double-glazed windows with a heat-reflecting film with a layer of oxide of metal, silver or titanium oxide, with chambers filled with gas: argon, krypton or xenon). A key area of energy saving in heating and hot water supply systems in buildings (where losses reach up to 70% of the total energy losses of the entire building) is the installation of an individual heat point (IHP), which automates and optimizes

the process of supplying the heat carrier to consumers. Such control units are produced by many Russian manufacturers; of the largest foreign structures selling IHP in the domestic market is Danfoss [9-10].

4 Discussion

Experts recommend metal pipe pipes, which have higher strength characteristics and provide long service life, as the most durable version of pipes.

One of the leading Russian manufacturers of common building metering devices is TBN Energoservis company. Its products are characterized by high quality, durability and protection of its devices from external mechanical influences and attempts to electronically hack them. One of the trends in energy saving in the housing and utilities sector is the per-apartment implementation of energy-efficient technologies, allowing residents to individually create the most comfortable microclimate with thermoregulators and thermostats (the most famous are Honeywell, Genius, Danfoss, Drayton, Hive, etc.).

Using ceiling infrared heaters, which heat not the air itself, but furniture and furnishings that give off heat, oxygen is not burned in the rooms, warm air practically does not accumulate under the ceiling, and heating itself is more uniform and the heat energy is used more efficiently (Almac, Ballu, Timberk, Friro, Ecoline and others).

It is recommended to install a variable frequency drive to increase the efficiency of the asynchronous motor, achieving energy saving in comparison with the throttle mechanism up to 60%, energy carrier transfer up to 25%, reducing the failure rate of heating and water supply networks, and avoiding water-hammer effects.

As an effective tool for optimizing the temperature regime of hot water and coolant, temperature controllers should be used to control it in an automatic mode, providing a comfortable room temperature for residents. Within the power supply system, it is recommended to use LED light sources: General Electric, Gauss, LG, Philips, Osram, Cosmos, Navigator, etc., smart power meters transferring data via various types of controllers (GPRS controller, LPWAN controller, or Wi-Fi controller). At the same time, the latter is the most optimal, capable of maintaining a stable connection and being fault tolerant.

As part of the automation of the lighting system, various types of sensors have proven themselves: a photocell, a digital timer with a weekly or annual program, an astronomical timer, a motion sensor providing savings up to 70% (Toyama, Schneider Electric, Lutron Electronics, Vantage Controls, etc.).

5 Conclusions

In modern conditions, the energy efficiency improvement of multi-apartment buildings has become an integral part of high-rise construction. The development of legislation in the field of energy saving in Russia contributes to the development of this area in our country. The research of the authors allowed to consolidate the most effective of the applied technologies as part of a single model. The authors believe that only the systemic and integrated introduction of energy-efficient technologies at all stages of the life cycle of the Moscow Ring Road provides the maximum energy effect, which brings tangible economic benefits to apartment owners, making their housing one of the most demanded in the modern real estate market.

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