

Organizational and technical support of compliance of the energy performance class with the performance standards for construction of high-rise residential buildings

Arkadiy Larionov ^{1,*}

¹Moscow State University of Civil Engineering, Yaroslavskoe sh., 26, Moscow, 129337, Russia

Abstract. Organizational and technical problems of energy efficiency in the construction of high-rise residential buildings were identified and systematized. The efficiency of state and regional policies in the field of energy saving and energy efficiency in high-rise housing construction and housing and utility services was stated to be largely determined not only by the level of modern constructional technologies and production of building materials, but also by the quality of full-scale measurements. The relevancy of scientific and methodological developments, allowing correctly to carry out the control over the compliance of actual indicators of energy efficiency of high-rise residential buildings with the given parameters, was substantiated. The contradictions of the goals and economic interests of suppliers and end users of energy resources were revealed. The conclusion was made that the solution of the problem of energy efficiency in high-rise housing construction was to harmonize economic interests and anticipations of the key market players.

1 Introduction

One of the strategic priorities of the state economic policy of the Russian Federation both in the post-reform period and at present is the creation and operation of multi-apartment houses with the active and widespread use of energy-efficient and energy-saving technologies, building materials and structures.

Energy efficiency is of particular relevance in Moscow's modern high-rise housing construction, as the agenda for energy efficiency and energy saving is dictated by the current challenges to the functioning of this key industry of the megapolis economy in the context of the global economic crisis, in general, and energy crisis, in particular. Therefore, the Government of Moscow pays close attention in its work not only to the development and widespread use of modern construction technologies in the high-rise housing construction and the use of energy-efficient building materials, but also to the quality of full-scale measurements.

* Corresponding author: proflarionov@mail.ru

The need for scientific and technical support for the development and implementation of measures, that are aimed at reducing the energy consumption of high-rise apartment buildings in Moscow and other large regions of the Russian Federation, is due to a number of objective reasons. This is due, among other things, to the fact that the energy characteristics of both new high-rise buildings and ones, that are under operation, are tens of percent lower in some cases than design indicators.

This result is directly related to the massive deviation of developers and construction companies from the correct application of design building materials and structures in order to reduce the expenses. The low performance discipline of contractors usually does not affect the reduction of the strength characteristics of the constructed facilities. However, the intention of developers to reduce the construction expenses at any cost in some cases leads not only to a decrease in the quality of housing construction, but also to the loss of the energy efficiency class of the constructed facilities.

2 Methods and results

In accordance with Directive 2010/31/EU of the European Parliament and of the Council of 19 October 2010 on the energy performance of buildings, energy efficiency should be calculated on the basis of a methodology that can be differentiated at the state and regional levels. This includes, in addition to thermal characteristics, accounting for other more significant factors such as heating and air conditioning, the use of renewable energy, passive heating and sectional cooling, dimming, indoor air quality, adequate natural lighting and building design.

The methodology for calculating energy performance should be based not only on the account of heating seasons, it should cover the annual energy efficiency of the building. This methodology should take into account current European standards.

According to Bloomberg [1], extraction, transportation and efficient use of energy has been one of the main world problems for the last decades. Moreover, according to the estimates of a number of experts [2], it will only become worse in the medium and long term outlook. Despite the very large reserves of explored and developed energy supplies, the solution of this global problem is also relevant for modern Russia.

This problem is most acute in the construction segment of all national economies. This is largely due to the fact that developers and buyers of housing projects are increasingly paying attention not only to the one-time price of the creation and acquisition of housing, but also to the expenses that they will bear during the period of its operation. Thus, energy performance is prioritised to other factors in terms of quality and competitiveness of high-rise housing projects in recent years.

The study results indicate that for Russian practice of energy-efficient high-rise construction the town planning experience of some European capitals seems to be the most valuable: consistent concentration of resources on a very limited number of sites, such as La Défense in Paris or London Docklands; conformity of building design to the principles of integrated urbanism with complex development and the deployment of transport networks at several levels; the complex design of the building due to the combination of objects of different functional purposes in buildings, the space-planning solution of which most harmoniously corresponds to their function, that means not the creation of multifunctional skyscrapers, but the combination of various buildings for different purposes in complex development; the combination of a wide range of buildings (offices, housing, hotels, public services, educational institutions, commercial spaces, entertainment and sports) in order to create an extensive range of jobs for the majority of the population of the complex and its full-fledged service - these points are to be primarily taken into consideration.

So, the practical solution of problems in this field was linked with the appraisal of the development of the national economy of the Russian Federation within the approved in 2003 "Energy Strategy of Russia until 2020": according to the "optimistic" scenario of this document, there should have been a decrease in the energy intensity of GDP in 2005 by 14-15% to the level of 2000; in 2010 - by 25-27%, in 2015 - by 35-40%, in 2020 - by 42-46%.

Such a dynamics in the field of energy consumption should be definitely promoted by the price policy of natural monopolies in relation to products and services. The drafters assumed that an increase in prices in the natural monopoly sectors, outstripping the level of inflation in industry, would lead to a redistribution of profitability from the main energy-intensive consumers in favor of natural monopolies and create conditions for energy saving.

Thus, the planned outstripping growth of energy prices should stimulate energy saving in all sectors of the Russian national economy, including construction and housing and utility services.

In the actual economic situation of the functioning and development of the national economy in general and, in particular, the construction of energy-efficient high-rise buildings, this should mean changing the existing technical and legal norms, rules and regulations that determine the consumption of fuel and energy in terms of tightening energy efficiency requirements; improvement of the rules for accounting and control of energy consumption; setting standards for energy consumption and marginal energy losses; mandatory certification of energy-consuming devices and equipment for mass application to establish their compliance with the energy performance standards.

There should be highlighted two important postulates in the Energy Strategy of Russia until 2020, that can be applied to construction: first, the energy intensity of high-rise construction must be steadily decreasing (the value of the constructed facility expressed in terms of units of equivalent fuel should be less than a previous year); second, a "planned" and also a steady increase in energy prices should encourage energy savings.

However, according to study results obtained by a number of Russian scientists and experts in the field of energy saving and improvement of energy performance of housing construction [3], regulatory requirements to reduce the energy intensity of construction at the government level for the period 2003-2016 were not put forward. And one problem was considered in the legal field: a steady decrease in operating energy costs, with a constant increase in tariffs for utility services, including heating costs.

The developers saw the organizational and technical solution of these problems in the formation of an integrated and approved regulatory and legislative framework; creation of energy markets with a high level of competition and fair principles of trade; the completion of reforms that bring adjacent sectors of the economy to a new level of energy efficiency; transition from the leading role of the fuel and energy complex in the country's economy to the natural function of an efficient and stable supplier of fuel and energy resources for the needs of the economy and the population.

The introduction of a fundamentally new concept of "energy performance", which is a relative value reflecting the ratio of the useful effect from the use of energy resources to the costs of energy resources, that are produced for the purpose to obtain such an effect, in relation to products, the technological process, a legal entity, an individual entrepreneur, has become topical.

At the same time, the legislator stressed that the energy performance requirements of buildings and structures should include indicators characterizing the specific amount of energy consumption (approaches to the main criteria in different versions of the federal law "On Energy Saving" can be presented in the form of Table 1).

Thus, following the logic of the current Federal Act No. 261, the indicator of specific energy consumption can not unambiguously determine the energy performance of the building (although it can be one of the components of energy efficiency). Therefore, it is

necessary to take into account the energy costs that would reduce the specific energy consumption.

Table 1. Comparative analysis of approaches to the main criteria formulated by the current and expired federal acts on energy saving.

Technical term	Federal Act No. 28 of 03.04.1996	Federal Act No. 261 of 23.11.2009
Energy saving	Implementation of legal, organizational, scientific, industrial, technical and economic measures aimed at the effective use of energy resources and the involvement of renewable energy sources into the commerce	Implementation of organizational, legal, technical, technological and other measures aimed at reducing the volume of energy resources used to maintain the appropriate beneficial effect from their use (including the volume of manufactured products, performed work , provided services)
Energy performance indicator	Absolute or specific value of consumption or loss of energy resources for products of any purpose established by state standards	
Energy performance		Characteristics reflecting the ratio of the useful effect from the use of energy resources to the costs of energy resources in order to obtain this effect, in relation to products, technological process, legal entity, individual entrepreneur
Energy performance class		Product characteristics, reflecting its energy performance

New goals were set in Russia in the field of energy performance which were reflected in the Roadmap for Improving the Energy Efficiency of Buildings and Structures ",in order to solve the organizational and technical problems of energy efficiency in high-rise housing construction in 2016, where two moments should be noted:

- firstly, the reduction of the payment load on the population for the housing and utility services by increasing the energy efficiency of the housing funds and by conducting capital repairs of apartment buildings and the developing the energy services of the housing funds;
- secondly, the creation of an incentive system to improve the energy performance of buildings and structures.

The results of research on the organizational and technical problems of energy efficiency in high-rise residential buildings in large Russian cities [4, 5] indicate that the agenda of energy efficiency and energy saving for high-rise housing construction is dictated by modern challenges in the functioning of this key economic sector in terms of the global economic crisis, and energy crisis, in particular.

This is the reason why the government of many Russian megacities pay very close attention in their work to this vector: the legislation in this field is under development and improvement; target integrated programs are being priority financed and carried out to improve the energy performance of high-rise housing construction and the development of utility infrastructure and energy saving; energy saving and energy efficiency in the housing sector are being actively promoted among enterprises and population (various forums, conferences, round tables are held).

The results of the author's research [6, 7] represent that new technologies, that are introduced into economic practice without appropriate qualitative evaluation of their

economic efficiency and qualified approbation, often lead not to a decrease in energy consumption, but, just the other way round, to its increase.

In this regard, scientific and methodological developments, that allow to correctly check the compliance of actual energy efficiency indicators of residential buildings with specified parameters, become particularly relevant. Therefore, a number of research workers of OAO "NIIMosstroy", a publicly held company under the laws of the Russian Federation, (with the participation of the article author) worked for the recent years to determine the reasons for the inconsistency of the objects under operation with the requirements of energy efficiency. And this group dwelling on the study are preparing to present for the Government of Moscow a set of measures in order to eliminate the excess over the design values of actual energy consumption of the commissioned buildings.

In our opinion, comparison of the principal provisions of the Russian Federation normative documents with similar provisions of European standards with a theoretical and experimental (full-scale) justification will allow the legislators to discover methodological and other differences. Whereas, the results of comparison of the obtained actual data (in particular, in Moscow apartment buildings commissioned within the last 3-5 years) in terms of compliance / non-compliance with their design values in energy efficiency classes can be used in order to adjust the existing house-building technologies.

The models, that were developed earlier [8, 9] and are currently under development by NIIMosstroy's research staff, will allow to take into account the influence of a number of characteristics on a specific energy consumption of multi-apartment residential buildings: heat input from sunlight during the heating season in Moscow's climate; heat emission from household appliances in a new building with different accommodation density; humidity of external walls and processes, which are related with their drainage, etc. The scientific value and practical significance of the results of the conducted studies is that the obtained data will be tested and confirmed by the results of numerical, laboratory and field experiments and measurements.

3 Discussion

Summarizing the results of the present work on the problems of ensuring energy efficiency in the construction and operation of multi-apartment houses, it should be emphasized that the effectiveness of state and regional policies in the field of energy saving and energy efficiency in housing construction and utility services is definitely largely determined by the level of modern construction technologies, building materials and structures, as well as the quality of full-scale measurements.

Though, unfortunately, it is impossible to solve this technical problem using only technical solutions. It is impossible primarily due to the strategic goal of natural monopolies, that are engaged in the development of various types of energy, resource-supply organizations and the Ministry of Energy of Russia, is to increase the production of traditional types of energy. And the goal of the end users of commodity construction products is energy saving and energy performance, i.e. the strategic goals of the main market players do not match.

It is necessary to develop and implement a set of organizational and economic measures that should be aimed at encouraging not only individuals, developers, construction contractors, construction industry enterprises and construction materials industry in order to eliminate this contradiction in goals, economic interests and expectations. Mainly, it is necessary to change the current systems of performance standards for the Ministry of Energy of Russia, natural monopolies, that produce various types of energy, and resource-supplying organizations

4 Conclusion

Thus, the organizational and technical solution to this technical problem of ensuring energy performance in the construction and operation of high-rise housing buildings is seen to meet the target indicators of the activities of the Ministry of Energy of Russia, natural monopolies, that produce various types of energy, and resource-supplying organizations with goals and objectives of construction contractors, developers, population, enterprises of building materials and structures.

References

1. V. Kankhva, IOP Conf. Series: Earth and Environmental Science **90**, 012175 (2017)
doi:10.1088/1755-1315/90/1/012175
2. R. Golov, V. Shilov, S. Silantiev, ASEE International Forum, Columbus **20766** (2017)
3. S.A. Bolotin, A.H. Dadar, *Nedvizhimost': ehkonomika, upravlenie* **3-4**, 11-15 (2010)
4. P.G. Grabovyy, *Nedvizhimost'. Ekonomika. Upravlenie* **1**, 4-9 (2011)
5. A.N. Larionov, *Vestnik grazhdanskih inzhenerov* **6(59)**, 297-301 (2016)
6. E. Nezhnikova, IOP Conf. Series: Earth and Environmental Science **90**, 012161 (2017)
doi:10.1088/1755-1315/90/1/012161
7. Ju. Panibratov, *World Applied Sciences Journal* **23**, 144-148 (2013)
8. N. Safronova, E. Nezhnikova, A. Kolhidov, MATEC Web of Conferences (2017)
doi:10.1051/mateconf/201710608024