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Increase of energy efficiency during overhaul of housing stock in Russian Federation

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Abstract. The construction sector covers various activities for the final consumption of energy resources, which have different consequences for energy consumption. Heating, cooling and lighting of premises for which most industrial energy consumption accounts for most of the energy consumption of buildings depend not only on the energy efficiency of the temperature and lighting control systems, but also on the efficiency of the buildings in which they are operating. The lack of generally accepted approaches to a comprehensive assessment of the effectiveness of the introduction of new energy efficient technologies, raw materials and equipment serves as a barrier to increasing the energy efficiency of domestic construction and overhaul of MAB. The article considers measures to increase energy efficiency during overhauls, which allow to reduce expenses for provision of housing and communal services and increase the market value of housing in the real estate market.

1. Introduction

The problem of energy efficiency is becoming critical in the 21st century, given the negative impact of energy technologies on the environment and the rising cost of energy resources. In Russia, energy efficiency is a resource for accelerating economic growth and a priority for transformational development of the economy. It should be noted that at present, Russia ranks 10th in the world in terms of energy consumption. In today's economy, no more than 1-2% of the potential for increasing energy efficiency is realized, 25% of the energy consumed by Russia is the residential sector, up to 15% of electricity and 50% of the heat energy does not reach the consumer.

The Russian Federation State Program "Energy Conservation and Energy Efficiency Improvement for the Period to 2020", developed in 2010, provides an assessment of Russia's energy saving potential (Table 1) [1].

It can be seen from the table that the construction industry has a high potential for energy saving. It is one of the main energy consumers, which poses the task of more rational use of energy resources at the stage of production of various building materials and operation of completed construction objects of various functional purposes.

Energy consumption in Russia for 2018 increased by 0.8% compared with 2017 [2]. As of January 2018, energy consumption increased by 0.3% in the Belgorod region's energy system, by 1.6% in the
Vologda region, by 0.2% in the Voronezh region, by 0.6% in the Kaluga region, as compared to the same period last year, the Lipetsk region by 0.7% [3].

Table 1. Estimation of the potential for increasing energy efficiency in selected sectors of the economy (million tons of equivalent fuel).

| Energy consumption sector         | Total | Coal | Raw oil | Oil products | Gas | Fuel spills | Electric power | Heat |
|----------------------------------|-------|------|--------|--------------|-----|-------------|----------------|------|
| Agriculture and forestry         | 4.15  | 0.03 | -      | 2.19         | 0.11| 0.06-       | 1.04           | 0.72 |
| Mining                           | 1.59  | -    | -      | 0.20         | -   | 2           | 0.53           | 0.86 |
| Construction                     | 0.73  | -    | -      | 0.29         | 0.01| 0.01        | 0.36           | 0.06 |
| Utilities                        | 1.01  | -    | -      | 0.01         | -   | -           | 0.51           | 0.49 |
| Heating                          | 41.11 | 0.82 | -      | 0.26         | 3.68| 0.27        | 0.28           | 35.8 |
| Hot water supply                 | 23.11 | -    | -      | -            | 3.60| -           | 0.25           | 19.26|
| Lighting (including transport infrastructure) | 3.15  | -    | -      | -            | -   | -           | 3.15           | -    |

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The problem of saving energy is undoubtedly urgent and vital. Exhaustion of natural resources, a negative impact on the environment and a high cost of energy are indicators to reduce energy consumption and production. Housing and communal services (utilities), industrial enterprises and mechanical engineering are the main consumers of energy [4].

2. Development of energy-efficient overhaul in the Russian Federation
Socio-economic problem of the housing and communal services sector in the territory of the Russian Federation is the provision of services for overhaul of buildings and structures [5-7]. Most buildings over-spend energy that goes to heating and cooling. The experience of other countries shows that overhaul takes into account the targets of the energy efficiency of modernization, the end result of which is the reduction of energy consumption while maintaining convenience and reliability.

In multi-apartment buildings (MAB), heat meters are recorded by counters due to low insulation of enclosing structures and the deterioration of in-house engineering systems. It should be noted that 40% of heat is lost through the walls, 18% through the roof and windows, 14% in ventilation, 10% in the basement. With an integrated approach to energy conservation, heat losses are minimized [8]. According to the federal law No. 261-FZ, energy saving is "the implementation of measures aimed at reducing the volume of energy resources used while maintaining the appropriate beneficial effect from their use" [1].

According to the current housing legislation, owners of residential and non-residential areas take part in the financing of the capital repair of MAB primarily through monthly contributions. In case of partial and untimely payment of contributions for the overhaul of the debt, they are levied compulsorily, taking into account the accumulated penalties and court costs of the regional operator. The collection rate in the Voronezh region was 90% for January-August 2018. The indicator exceeded the average level of Russia in payment of contributions.
Before each region, the task is to conduct a qualitative overhaul with the use of modern building materials. In the Voronezh region, a multi-level system of departmental and public supervision operates over the course of overhauls of multi-apartment buildings. A list of qualified contractors has been compiled and regularly updated. However, measures to improve the energy efficiency of buildings are not included in the list of mandatory works for overhaul. The residents themselves can make this decision. By agreeing among themselves, they choose additional measures from the list developed by the Ministry of Construction of the Russian Federation for energy-efficient overhaul. The selected options require additional attachments. If the building energy consumption is reduced by 10%, tenants will receive financing up to 50% or subsidize the interest rate on the borrowed loan from the Fund for Assistance to Housing Reform. The support has been in effect since January 2017 under the Decree of the Government of the Russian Federation on the financial support of energy-efficient overhaul.

In 2017 in the city of Voronezh major repairs of two houses with the use of energy-saving technologies were made. Residents have cut utility costs by at least 10%.

3. Measures for energy saving in houses during major overhaul

According to the "Practical manual on increasing the energy efficiency of apartment buildings during major repairs" [9], developed by the Fund for the Promotion of Housing Reform, packages of energy-efficient measures have been formed for selective overhaul of the MAB and ensuring compliance with regulatory requirements for energy efficiency. They are combined in accordance with the principle of ensuring the achievement of normative indicators of energy efficiency and specific energy consumption corresponding to the period of putting the MAB into operation after repairs. Among the methods of energy saving, there are 4 directions [10-12]:

- ensuring effective thermal insulation;
- reduction of heat losses in the ventilation system;
- ensuring the tightness of window and door openings;
- reducing the power consumption by introducing modern economical devices.

With increasing energy efficiency in the construction sector, you can often encounter such barriers:

- lack of reliable and veracious information on energy efficiency and the costs and benefits of improving efficiency;
- budget constraints of local self-government;
- high transaction costs due to small individual investments;
- unattractive financial profit;
- the risk to unfamiliar materials, methods and equipment, or uncertain results.

Based on these data, it is necessary to take measures to overcome these barriers and improve existing methods of increasing energy efficiency. The policy of increasing energy efficiency is mainly focused on the "shell" of buildings, rather than on heating and ventilation equipment, although if you focus on equipment, you can significantly increase the energy-saving potential. There is a great potential for achieving greater energy savings by establishing and improving the regulatory framework of the Russian Federation [13]. Increasing efficiency by 10-20% is possible in most countries thanks to only the instruments, equipment and lighting products that can be purchased today. Therefore, the search for ways to optimize energy consumption in the construction sector is an urgent and extremely important direction of the country's development [14,15].

To carry out major repairs of multi-apartment buildings in order to increase energy efficiency, the following activities are necessary:

1) an increase in the degree of thermal protection of external walls to the standards of 2016-2020. Maintenance does not require additional costs. The life span corresponds to the life span of the building.

2) an increase in the degree of thermal protection of windows and balcony doors to the standards of 2016-2020 g. Operating costs - 0.5% of the capital annual maintenance costs. Life span is 15 years.
3) sealing of external entrance doors in the entrances with the installation of door closers (ensuring automatic closing of doors). Operating costs - 5% of the capital annual maintenance costs. Life span - 6 years.
4) the device of the radiator reflux screens (Fig. 1). Maintenance does not require additional costs. Life span is 15 years.
5) additional sectional entrance tambours (Fig. 2). Maintenance does not require additional costs. The life span corresponds to the life span of the building.
6) installation of common house heat metering devices. Operating costs - 1% of the capital annual maintenance costs. Life span is 10 years.
7) installation of a common house hot water meter. Operating costs - 1% of the capital annual maintenance costs. Life span is 10 years.
8) installation of an automated control unit for the heating system. Operating costs - 4% of the capital annual maintenance costs. Life span - 20 years.
9) installation of balancing valves (vents) on the vertical risers of the heating system (Fig. 3). Operating costs - 1% of the capital annual maintenance costs. Life span is 10 years.
10) mounting of thermostatic valves (thermostats) on the heating devices (Fig. 4). Operating costs - 1% of the capital annual maintenance costs. Life span - 10 years.

**Figure 1.** Schematic illustration of the device of the radiator reflux screens [9].

**Figure 2.** Schematic illustration of the additional sectional entrance tambours [9].

**Figure 3.** Schematic illustration of the installation of balancing valves on the vertical risers of the heating system [9].

**Figure 4.** Schematic illustration of the installation of thermostats on radiators [9].

### 4. Conclusion

Studies [18-22] have identified the need for the short term to take the following measures to improve energy efficiency:
the adoption of policy measures that promote the efficient use of resources;
expansion, recycling and informing consumers about possible options for reducing the use of
natural resources;
development and introduction of economic models into practice.

All of the above energy efficiency measures will be aimed at reducing the amount of energy
consumed, while maintaining the quality of services provided in buildings.

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