

The impact of energy efficiency on choosing the strategy of technical policy development

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Abstract. This article addresses two variants of the strategy for the development of technical policy. These variants depend on the energy efficiency requirements of the materials and building structures. Strategy 1 is *Economy variant* and Strategy 2 is *Pragmatic variant*. To analyze the feasibility of the proposed types of strategies at the initial stage, we chose 10 most common types of apartment buildings in the Samara region. All other criteria were secondary: building height and, as a consequence, an elevator (elevators) available, total area, material and engineering aspects of the roof, foundation and engineering systems.

1 Introduction

Developed technical policy is a policy document for the activities of timely total renovation of common property in apartment buildings in Samara region by means of money contribution of owners of premises.

Technical policy is used for decision-making in the sphere of Housing and Utility Infrastructure [1] by the *Total Renovation Fund* non-profit organization. Technical policy should be taken into account by all entities performing total renovation of apartment buildings on the territory of the Samara region, regardless of their organizational and legal forms or forms of ownership.

From the moment of approval, technical policy is applied for the preparation and execution of works on total renovation of apartment buildings in Samara region.

Technical policy is a complex system of measures grouped into two fundamental strategies; each of which determines the general direction of long-term development options and types of work anticipated for each type of apartment buildings located on the territory of the Samara region.

The study covers a wide range of issues related to the establishment of multi-family housing parameters located on the territory of the Samara region, involves various types of research and calculations (thermal, technical, economic, etc.), as well as identifies the parameters that require further study, defines a set of measures and types of works

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depending on typology of buildings, models the effects of the implementation of a strategy option.

The developed system of performing total renovation in the Samara region includes preparation, development and approval of integrated solutions aimed at improving the engineering, functional, planning, environmental and other conditions of apartment buildings to ensure the smooth and controlled implementation of activities on total renovation of apartment buildings in Samara region.

Technical policy is a mechanism for making optimal decisions when choosing a working option on total renovation of apartment buildings that enhances the performance of buildings and their energy efficiency [2]. The work is based on the complex of analytical, graphical, calculated and textual research data of the Contractor.

Relations in the field of total renovation are regulated by a number of regulatory legal acts of the Russian legislation [3-10].

2 Methods

The purpose of technical policy is effective decision-making while implementing the regional program of common property total renovation in apartment buildings located on the territory of the Samara region in accordance with the requirements of the Russian legislation.

Based on the objectives of the technical policy, its tasks are defined as follows:

- Development of tools for operative management of the common property total renovation of apartment buildings located on the territory of the Samara region;
- Development of rules on the choice of technically sound engineering solutions and building materials, rational approach to planning and arrangement of works.

Research stages:

1. Analysis and systematization of the initial data on apartment buildings located on the territory of the Samara region.
2. Development of the classification of apartment buildings according to the technical characteristics, taking into account the total cost of total renovation.
3. Drawing up the directory of recommended for use technical and technological solutions for the total renovation of individual components, taking into account the most efficient building materials and equipment (mainly of domestic developers protected by patents).

3 Results

Depending on the requirements of the existing legal documents and taking into account the experience of performing total renovation of apartment houses, we offered two variants for technical policy implementation. The choice is determined by the individual technical specifications of a particular type of an apartment building, taking into account the wear and tear of its main structures and equipment, meeting the requirements of energy efficiency and the amount of funds actually invested in the repair of the apartment building. The decisive factor in choosing a strategy for the implementation of technical policy is the availability of funds for total renovation of apartment buildings.

Strategy #1 – **Economy variant** - is aimed at maintaining the building in a condition suitable for further normal operation; it involves selective total renovation with certain types of work. As a result of this strategy, in each object of total renovation worn-out materials and structures are replaced with similar modern ones, the choice of technical and technological solutions in this case is determined by the criterion of efficiency. According

to the economy variant, the choice variability of catalogue technologies is carried out in accordance with the following evaluation criteria:

- Ensuring efficient operation of an apartment building during standard term of maintenance;

- Energy efficiency;

- Minimization of non-recurring costs of total renovation [2, 11].

Strategy #2 – **Pragmatic variant** - is aimed at reducing the wear and tear of apartment buildings improving the performance of buildings and improving living conditions of citizens. As a result of this strategy, in each object of total renovation worn-out materials and structures are replaced with effective modern ones. According to the pragmatic variant, the choice variability of catalogue technologies is carried out in accordance with the following evaluation criteria:

- Increase of the period of effective apartment building operation beyond standard maintenance term;

- Energy efficiency;

- Minimizing ongoing costs in the operation of the apartment building.

Of the two strategies, the second one (pragmatic variant) is the most rational. According to an embodiment of the pragmatic variant, residents receive a significant amount of services for total renovation, and housing and communal services achieve the average values in terms of costs. Building service time until the next total renovation increases, and therefore return of incurred costs becomes more efficient.

To analyze the feasibility of the proposed strategy types, 10 of the most common types of apartment buildings in the Samara region (Table 1) have been selected in the initial stage. Typology has been developed taking into account the convenience of the efficient performance of apartment houses total renovation. Each type is conditioned by the material and design features of load-bearing structures of buildings, their construction period, part of footage of each type of apartment building in total housing stock, as well as features of the technical parameters of each object for total renovation.

Table 1. Main Types of Apartment Buildings

Item #	Number of building type	Name	Part in the total housing stock, %
1	1	Historic premises	0.10
2	2	“German” premises	1.50
3	3	Pre-war premises	5.10
4	4	“Stalin” premises	5.30
5	5	“Khrushchev” premises	32.07
6	6	“Co-operative” premises	14.08
7	7	Bed-sitting premises	2.23
8	8	“Developed socialism period” premises:	
8a		Period of 1968-1980	26.71
8b		Period of 1978-1995	6.30
9	9	Modern premises	6.29
10	10	Soviet rural premises	0.20

For the convenience of research with multi-family houses of different typologies, calculations are carried out for one section of a building or apartment building with one entrance. This allows to increase the volume of work, depending on the number of sections (entrances).

Following the two strategies, the specific cost of total renovation of an apartment building will be defined (rubles/ m²) for each of the building types.

For each of the building type, average specific economy of utility resources per 1m² will be determined. This component increases during the transition from strategy #1 to strategy #2 and varies depending on the type of apartment building. For each of the apartment building types a percentage of the economy of thermal energy, electricity [11], gas and water is defined differentially as per two proposed development strategies.

The choice of a strategy will be determined by the amount of funds for total renovation of apartment buildings in the Samara region. Choice of the first strategy (economy variant) means the inertial course of development and represents a starting point for development of technical policy. This course involves the total renovation of the buildings that have been in operation for more than 40 years. Approximately half of the objects will be subject to comprehensive repair (3-15 types of work), and another half will be subject to selective repair (1-3 types of work). This option allows to maintain relatively stable situation; significant deterioration of the housing stock in this case is not expected.

Choosing the second strategy (pragmatic variant) will mean a progressive course of development and optimal technical policy for the present moment. The buildings that have been in operation for 40 years or less will be subject to total renovation. More than 50% of the objects will be subject to comprehensive repair. The planned reduction of energy costs should be no less than 15%. The best option allows permanent reduction of the proportion of houses in need of total renovation.

Both strategies should be developed taking into account energy efficiency; they should follow a course for sustainable development in which the vast majority of objects will be subject to complex repair. Energy-efficient approach to managing total renovation will cover, in the nearest future, all buildings older than 40 and a significant part of the buildings with a lifetime of more than 25 years. The latter variant would significantly improve the condition of apartment buildings. In the future, the planned reduction in energy consumption should be no less than 30%.

Technical policy implementation program is an algorithm of works according to which each apartment building is subject to total renovation.

This algorithm is proposed to conduct works on total renovation of apartment buildings situated on the territory of the Samara region.

The algorithm provides the following sequence of activities:

1. Preparation of the facility certificate for an apartment building.
2. Technical inspection of the apartment building in terms of each type of works (services) on total renovation.
3. Drawing up statement of defects for each type of works (services) on total renovation.
4. Checking compliance of each type of work (services) of total renovation with modern regulatory requirements.
5. Choosing the technology according to the catalogue with the following options:
 - Restoration works;
 - Replacement;
 - Modernization (replacement with improved performance);
 - Installation of extra construction and technological elements.
6. Variation of choice on technology catalogue in accordance with the proposed evaluation criteria:
 - Minimization of non-recurring costs of total renovation;
 - Minimizing ongoing costs in the operation of the apartment building;
 - Energy efficiency;
 - Increasing the term of apartment building efficient operation.

7. Full list of works (technological operations) for each object of total renovation.

8. Determining the scope of work based on the chosen technology and with the preparation of statement of defects that lists the worn-out materials and constructions that are subject to replacement.

9. Evaluation of construction works carried out on the basis of statement of defects.

According to Article 36 of the Federal Law [10]:

- The safety of buildings and structures in operation is provided by the maintenance, periodic inspection and audit and (or) monitoring conditions of foundation, building structures and systems of engineering and technical support, as well as through current repair of buildings or structures;
- Parameters and other characteristics of building constructions and systems of engineering and technical support during the operation of a building or a structure shall conform to the requirements of the project documentation;
- Operation of buildings and structures must be organized in such a way as to make the buildings comply with energy performance requirements of buildings and structures and with the requirements of equipping buildings and structures with metering devices of utilized energy resources throughout the life cycle of buildings and structures.

According to Article 6 of the Federal Law #384-ФЗ, the Government of the Russian Federation approves the list of national standards and regulations (parts of such standards and regulations), as a result of which compliance with minimum requirements for the safety of buildings and structures, as well as design process related to buildings and facilities (including research), construction, installation, commissioning, operation and disposal (demolition) shall be provided on a mandatory basis.

Requirements for buildings and facilities, set by [10], shall not apply until the reconstruction or total renovation of the building, or structure, commissioned before such requirements came into effect (Article 42 [10]).

Thus, Russian legislation does not establish a mandatory list of works carried out during total renovation, but it contains requirements on the mandatory provision of the safe condition of the buildings in the course of their operation, and safety issues also include energy efficiency of buildings.

After the adoption of the Federal Law [9], total renovation of buildings has become closely associated with the norms of energy efficiency and energy saving. According to Article 11 [9], the requirements of the energy efficiency of buildings and structures should include requirements for certain elements, structures of buildings, constructions and their properties, to devices and technologies used in buildings, structures and constructions, as well as requirements for technologies and materials included in the project documentation and used during the construction, reconstruction, total renovation of buildings and structures, which enables to eliminate wasteful consumption of energy resources both in the process of total renovation of buildings and structures, and in the course of their operation.

The requirements of the new legislation apply in full to all the buildings that have undergone total renovation in terms of energy efficiency. Total renovation, along with reconstruction, is frequently the legal fact and the turning point that marks the beginning of the application of the new requirements for building.

According to part 6 of the Article [9], commissioning of buildings, structures, that have recently been renovated and do not comply with the requirements of energy efficiency and those of equipment and metering devices for measuring energy resources, is not allowed. Part 7, Article [9] points out that developers are required to ensure that the buildings and structures meet the requirements of energy efficiency and the requirements of their equipment with metering devices for measuring energy resources by choosing optimal architectural, functional and technological, construction and engineering solutions and their proper implementation while performing total renovation.

Part 10 of the Article [9] points out that in case of discovery that building, structure, or facility, or their individual elements and design do not meet requirements of energy efficiency and (or) requirements of their equipment with metering devices for measuring energy resources, arising from non-compliance by the developer of these requirements, the owner of the building, structure or structures, owners of premises in an apartment house has the right to demand from the developer either free elimination of the identified inconsistencies within a reasonable time, or refurbishment made by them to eliminate a detected nonconformity. Such a requirement can be put forward to the developer in case of non-compliance being detected within a period during which, according to the requirements of energy efficiency, this compliance should be ensured during the design, construction, reconstruction, total renovation of buildings, structures and constructions.

According to part 7 of Article 13 [9], apartment buildings, entered into operation starting from January 1, 2012 after total renovation, should be equipped with individual metering devices for consumed heat energy when it is technically possible to install them. The owners of the metering devices of utilized energy resources are required to ensure proper operation of the metering devices, their safety and timely replacement.

The State takes measures aimed at ensuring compliance with requirements for the proper state of apartment buildings, complementing already existing Article 7.22 in the Russian Federation Code of Administrative Offences. Article 37 [9] amended the Code of Administrative Offences of the Russian Federation: Chapter 9 is supplemented with part 9.16 according to which failure to comply during the total renovation of buildings and structures with energy efficiency requirements, requirements of their equipment with metering devices for consumed energy resources is subject to an administrative fine for officials in the amount of twenty thousand to thirty thousand rubles; to persons engaged in entrepreneurial activities without forming a legal entity - from forty thousand to fifty thousand rubles; for legal entities - from five hundred thousand to six hundred thousand rubles.

The requirements of the new legislation on energy efficiency apply to buildings after total renovation. According to regulatory documents [12, 13], total renovation, reconstruction and construction of new residential premises should be carried out in accordance with the special requirements for thermal protection of building envelopes. These standards specify the requirements for:

- Given thermal resistance of building envelopes ($R_o, m^2 \cdot S$);
- Heat-resistance of building envelopes and premises in cold seasons;
- Protection of building envelopes from excessive moistening;
- Air permeability of building envelopes and premises;
- Prevention of moisture condensation on the inner surfaces of building envelopes;
- Specific indicators of heat consumption for heating buildings;
- Improving the energy efficiency of buildings after total renovation or reconstruction, as well as for new buildings under construction.

Taking into account the new regulatory requirements the desired thermal resistance of building envelopes should not be considered lower than the standard value which is dependent on the degree-days of the heating period (HSDD method, $C \cdot \text{days}$). Using HSDD method takes into account the climatic factor for different regions of the Russian Federation.

Article 15 [10] states that after the total reconstruction by state construction supervision authority in accordance with the rules approved by the authorized federal executive body for the class definition of energy efficiency of apartment buildings [14, 15], the requirements for which are set by the Russian Government, a class of energy efficiency of apartment building is defined. Energy efficiency class of apartment building put into operation is indicated in the resolution of state construction supervision body about the

conformity of the constructed, reconstructed or totally renovated apartment building with energy efficiency requirements. Energy performance certificates for buildings, structures, facilities put into service after total renovation, can be formulated on the basis of design documentation.

Requirements for class definition of energy efficiency of apartment buildings are established [14]. According to Part 1, these requirements apply to buildings after reconstruction or total renovation. According to Part 2, the energy efficiency requirements for buildings, recently totally renovated, are set differentially depending on the type of repair.

However, part 7 [16] states that, for the reconstruction of buildings and economy-class housing, decrease in standard specific energy consumption for heating and ventilation goals on the energy efficiency class H ("high") in relation to the baseline should be 15% from 2016 and additional 15% from 2020. It also points out that the reduction in specific water consumption in residential buildings should not exceed 175 liters / person by 2020, including hot water - 80-85 liters / person. Part 1 of the stated order establishes that the requirements are minimum acceptable and must be respected during the designing, examination, construction, approval and operation of new, reconstructed, totally renovated and modernized heated residential buildings.

There is a contradiction between these two above mentioned documents: Government Resolution [14] states that the energy efficiency requirements in respect of buildings after total renovation are set differentially depending on the type of total renovation; and the Order of Ministry of Regional Development [16] firmly sets the task to reduce specific costs on the basis of total renovation.

Part 14 [16] establishes a wide list of energy saving measures as part of total renovation, and the building should be equipped with:

1) Heating devices used in public places with energy efficiency class not lower than the first two (if classes have been defined);

2) Elevators with the class of energy efficiency not lower than two (if classes have been defined);

3) Devices automatically controlling the supply of heat for heating, installed at the building entrance facility, structure or construction, as well as on the facade of the building;

4) Thermostats and meters of heat energy consumption flow, installed on radiators of vertical heating systems; thermostats on radiators and heat carrying agent flow meters in horizontal apartment-by-apartment systems of heating apartments with a total area up to 100 m², or with heat meters for apartments with larger flat space;

5) Heat exchangers for heating water for hot water supply with the unit for automatic regulation of its temperature installed at the building or part of the building entrance facility;

6) Electric motors for fans in ventilation systems, elevators, moving water in the in-house heating systems, hot and cold water, air-conditioning systems;

7) Metering devices for measuring energy and water resources, installed at the building entrance facility, in apartments, common and leased areas;

8) Devices, optimizing ventilation systems (air passing valves in windows or walls, automatically ensuring the supply of outside air on demand, utilizers of exhaust air heat for heating supply air, the use of recycling);

9) Water pressure regulators in cold and hot water systems at the building, construction, structure entrance (for apartment buildings –at building entrance, in apartments, common areas);

10) Devices that automatically reduce air temperature in the premises of public buildings after certain hours in winter;

- 11) Devices that reduce the peak load in refrigeration systems through the use of chilled ceilings for accumulation of cold at night;
- 12) Energy-efficient lighting in common areas;
- 13) Equipment providing switching off lights when no one is in the common areas (motion sensors, switches);
- 14) Reactive power compensation when electric motors are in operation;
- 15) Door closers (in apartment buildings - for all doors in the common areas);
- 16) Second door in the vestibules of entrances, ensuring minimal loss of heat energy, or revolving doors;
- 17) Stops for opening windows (for apartment buildings - in common areas, apartments).

The requirements of energy efficiency in relation to the buildings after total renovation are set differentially depending on the type of total renovation according to [14], and the order of Ministry of Regional Development [16] sets firm tasks to reduce the costs of specific energy consumption on the basis of total renovation. In case of such contradictions, the principle of the priority of legislative acts, having a higher legal status, is the guiding one. In this case, the Resolution of the Russian Federation Government has a higher status [14].

4 Discussion

Thus, the following should be considered when performing total renovation of apartment houses:

- Russian legislation contains requirements for safety and energy efficiency of residential buildings in the course of their operation. However, requirements established by the legislation do not apply to the buildings put into operation before the coming of these requirements into effect, until their reconstruction or total renovation;
- Existing lists of works on total renovation are not obligatory for building owners. But when making a decision to perform total renovation and the types of works on total renovation, the result of such works should be in compliance with the requirements for energy efficiency of buildings and equipment with meter devices for measuring consumed energy resources;
- Requirements of existing building standards and codes of rules allow to provide energy efficiency in constructed, totally renovated and reconstructed buildings;
- There is a need not so much in developing new regulatory requirements relating to total renovation of apartment buildings as in greater harmonization and enforcement of already existing regulations.

Conclusions

To ensure the greatest economy of resources, increase the service life and durability we need an integrated approach to the use of energy-efficient building constructions, materials and technologies. This is particularly important while ensuring efficient operation.

Economy of funds when choosing the strategy 1 (economical variant) leads to decrease in construction service life, whereas the more expensive variant 2 provides a pragmatic approach. To select a variant strategy for total renovation of each particular object, one must explore the possibilities of its full functionality and the required costs in comparison with the service life and physical and moral deterioration of its basic structural elements.

The potential for energy efficiency is highly dependent on the skill and experience of the authors and performers of the project. The use of modern energy-efficient constructions, materials and technologies allows to relate energy consumption to various indicators of the

price range, comfort, environmental impact and leading to lower costs while improving the quality in the long term.

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