Energy saving methods during the life cycle of buildings and structures: energy service contracts

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Abstract. The scientific article examines the problems and solutions that can be applied in the process of managing the life cycle of construction projects. As an example, a budgetary institution is proposed in which it is necessary to improve energy conservation. The proposed mechanisms that can be applied to budgetary institutions are the most optimal, since there is no funding for energy-saving measures. In order for the entire system of energy service contracts to work effectively, mandatory participation of local governments must be provided. They, in turn, will select suitable energy service contract schemes, draw up methods for paying expenses and conditions for sharing the profits received from saving energy resources for the entire period of the contract.

1 Introduction

Carrying out major repairs in apartment buildings is one of the most pressing issues in the housing sector. However, the existing mechanisms for the organizational and technological implementation of major repair projects do not always provide a sufficiently high level of efficiency, and do not always use modern technologies that can improve quality and reduce financial costs for the work [1-5]. Therefore, improving the mechanisms for the organizational and technological implementation of projects and the use of energy-efficient technologies are urgent tasks.

Energy-efficient repairs will help reduce energy consumption, which will reduce utility bills, prevent rapid wear and tear of utility systems, which will reduce financial and material resources for maintaining an apartment building in good working order [6-9]. Energy-efficient major repairs will improve the comfort of living in houses with a modernized energy consumption system.

Major repairs are an integral part of the life cycle of buildings and structures, and their implementation allows you to preserve and extend the service life of real estate. In addition, major repairs also help improve the energy efficiency of buildings and improve living and working conditions for people.

Major repairs of apartment buildings include a wide range of works and these works may vary depending on various situations.

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It is worth noting that the use of modern technologies and new materials increases the energy efficiency of apartment buildings, in this case, major repairs involve the installation of a modern heating system, insulation of the facade and roof, installation of meters and automation. These measures reduce energy consumption costs and contribute to environmental protection [10-12].

2 Methods

In the Russian Federation, most apartment buildings consume much more energy than they need. Apartment buildings in the Russian Federation have low energy efficiency, and energy losses in most cases occur due to the lack of automatic temperature control sensors, which results in energy losses that are used for heating and water heating, and overheating [13-15].

There are several reasons for such a slow implementation of energy-efficient technologies in the country:

- lack of energy saving programs;
- lack of awareness of apartment building residents and lack of interest in energy saving issues;
- lack of mandatory requirements for improving the energy efficiency of already constructed buildings.

What is an energy service contract? This is an agreement to ensure the implementation of energy-saving measures and technologies. These measures and technologies must be implemented by specialized energy service companies that comply with all the rules and regulations for ensuring energy conservation and the use of energy-efficient methods.

Energy service companies apply energy-saving technologies at the customer's (budgetary institution's) facility, using funds received from credit institutions (credit funds).

After energy-saving technologies have been implemented and are actively used, the energy-saving project has been completed, the customer pays the credit institution the funds that were used. In this case, the customer pays from the financial resources that were saved due to the implementation of energy service contracts.

A contract for energy service measures is most often concluded for a period of five to ten years. During this period, payments are made [16-18].

Fig. 1 shows a diagram of the procedure for implementing an energy service contract.

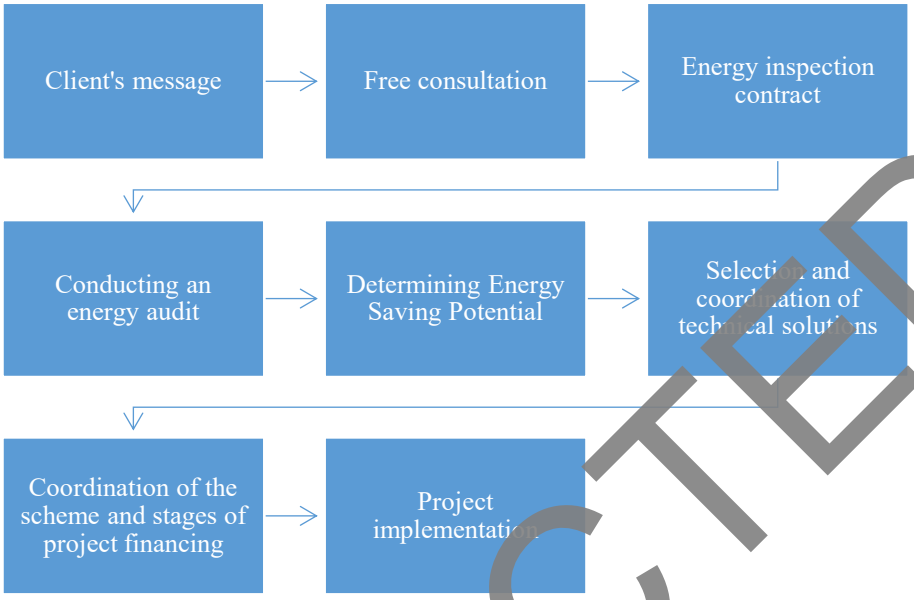


Fig. 1. Algorithm for the procedure for concluding an energy service contract.

Areas of work in the field of energy efficiency regulation:

1. Creation of a comprehensive energy efficiency improvement program.
2. Development and implementation of mechanisms for regional and municipal support of energy efficiency programs.
3. Development and provision of energy efficiency target indicators, requirements for reducing the volume of consumed resources
4. Implementation of energy-saving technologies aimed at reducing resource consumption
5. Updating the list of energy efficiency measures and the equipment and technologies used.

If we consider a budgetary institution as an example for the implementation of energy service contracts, then the life cycle of such a building can be managed. Energy service activities and technologies in this case are divided by building structures and engineering systems of a specific building (Fig 2-7):

Power supply systems 	Reducing electricity losses in cable networks
	Maintaining nominal voltage levels in networks
	Uniform distribution of loads across phases
	Equipping power supply systems with monitoring systems for electrical energy consumption
	Reducing the number of personal household appliances (boilers, coffee makers, electric kettles, etc.)
	Introduction of energy-saving burners on electric kitchen stoves
	Installation of thermostats on electric heating systems
	Optimizing the time of use of office equipment

Fig. 2. Power supply systems.

Lighting systems 	Reducing energy consumption for lighting purposes by reconstructing the existing lighting system through the installation of energy-efficient light sources
	Replacement of old modification fluorescent lamps with new generation lamps of lower power
	Replacement of traditional lighting systems with LED ones
	Replacement of electromagnetic ballasts for fluorescent lamps with more reliable and economical electronic ones
	Painting the walls of the premises in lighter colors
	Decentralization of lighting switching by installing several switches and dividing the lighting area into the necessary zones

Fig. 3. Lighting systems.

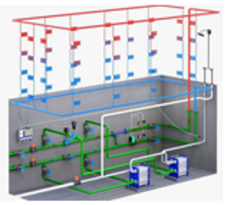
Heating systems 	Drawing up manuals for the operation, management and maintenance of heating systems, periodic monitoring by the management of the institution over their implementation
	Equipping heating systems with metering devices
	Hydraulic adjustment of the internal heating system
	Annual chemical cleaning of internal heating surfaces of the heating system and heat exchangers
	Automation of heat supply systems for buildings by installing individual heating points (IHP) with regulation of heat supply
	Removing decorative fences from heating radiators
	Installation of heat reflectors behind heating radiators
	Installation of thermostatic shut-off valves on heating radiators
	Replacing a single-pipe heating system with a two-pipe one
	Installation of thermal curtains

Fig. 4. Heating systems.

Hot water systems 	Drawing up manuals for the operation, management and maintenance of hot water supply systems, periodic monitoring by the management of the institution over their implementation
	Automation of regulation of the hot water supply system
	Ensuring water recirculation in the hot water supply system
	Reducing consumption by optimizing costs and regulating temperature
	Equipping hot water supply systems with hot water flow meters
	Reduced heat losses during transportation through pipes through insulation
	Introduction of thermal insulation of pipes based on ultra-thin thermal insulation coating
	Use of economical water fittings
	Reducing water costs and losses

Fig. 5. Hot water systems.

Water consumption	
	Replacement of worn steel water supply pipelines
	Introduction of recycling water supply systems
	Implementation of water treatment systems
	Application of economical water taps
	Reduce water costs and losses

Fig. 6. Water consumption.

Building and enclosing structures	
	Reducing thermal heat loss through window openings by installing a third glass or PVC film in the interframe space of the windows
	Reducing thermal heat loss through window openings by installing low-emissivity heat-reflecting films on window glass
	Additional glazing with cellular polycarbonate
	Improving the thermal insulation of facades, ceilings, walls, floors and attics, roofs, etc.
	Reducing thermal heat loss by sealing interpanel and expansion joints
	Hydrophobization of walls (hydrophobic wall coating)

Fig. 7. Water consumption.

3 Results

Energy service contracts are long-term. Thus, local governments can draw up methods of payment for contract expenses in advance, determine the conditions for distributing profits received as a result of energy service activities. They can distribute funds throughout the entire term of the energy service contract. Different countries may use their own variations of energy service contracts. They differ in their financing mechanisms (Fig. 8).

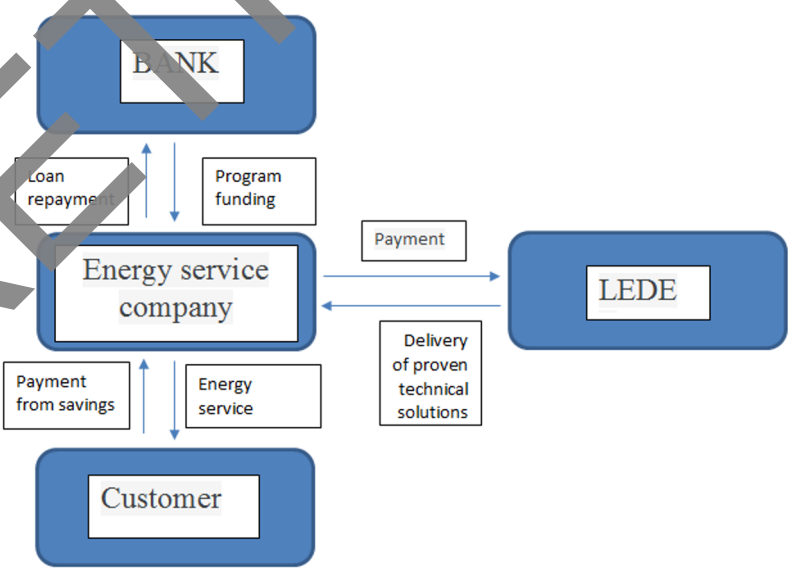


Fig. 8. Types of contracts by financing mechanisms.

The ways in which energy service contracts and budget organizations can interact are quite diverse and have certain limitations.

In organizations that belong to the budgetary sphere, energy service contracts can be used quite effectively. Regulatory and legal documentation allows municipalities and unitary enterprises to participate in such contracts.

To do this, it is necessary to comply with a number of requirements:

1) in the event that budgetary institutions do not fulfill the obligations that were assumed under the energy service contract, hold them accountable

2) methods for monitoring comfort and actual consumption of energy resources must be determined (so that there is no excess consumption of electricity and other resources)

3) it is important to choose the optimal method for calculating the formation of the price for utilities specifically for budgetary institutions;

4) it is important to take into account the possibility and conditions of early termination of the contract.

Fig. 9 shows a diagram of the possibility of saving funds from the budget in the case of effective implementation of energy service contracts.

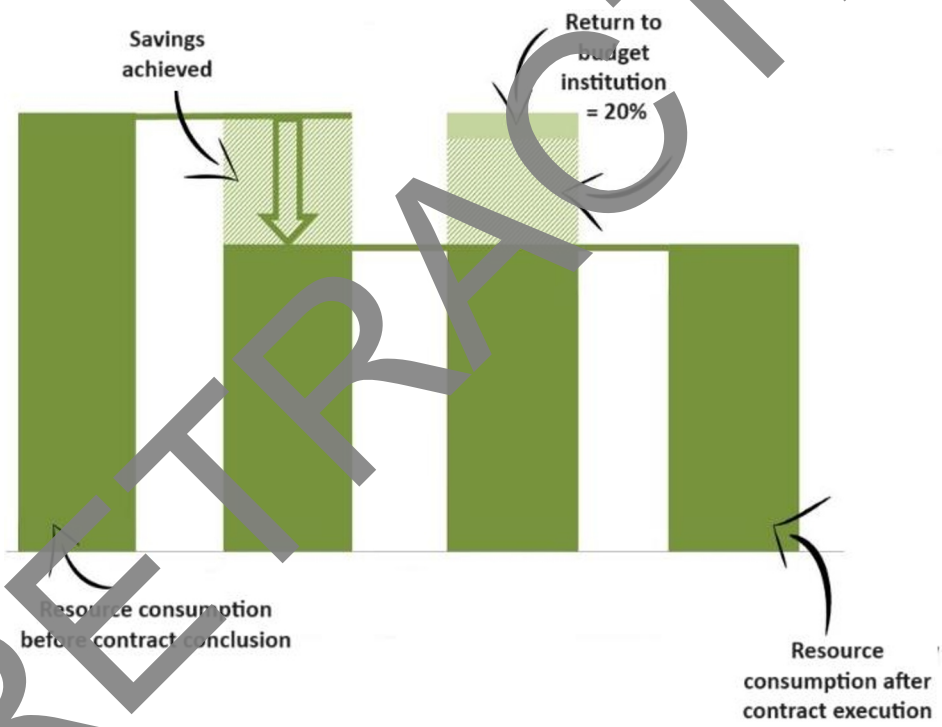


Fig. 9. Budget savings.

4 Conclusions

The analysis revealed that the traditional approach to energy saving with the help of such energy saving measures as energy audit and further implementation of selected projects is assigned to the budget institution that needed to improve the energy saving system. Thus, it was shown that the most optimal and rational approach is to implement energy service contracts. This will help transfer all complex energy saving measures, as well as risks before the results are achieved, to energy service contracts. As a result, it will be possible to

reduce energy consumption and improve the energy efficiency of buildings related to budget organizations.

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