

# The implementation of energy-service contracts in the Republic of Sakha (Yakutia) as a tool to reduce government spending: experience and prospects

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**Abstract.** The article analyses the results of implementation of the energy-service contracts in the Republic of Sakha (Yakutia). A review of the Russian energy service market has been completed. Real savings of energy carriers according to metering devices in public enterprises, indicating the effectiveness of the technologies used, have been achieved. The used energy-saving technologies and solutions that allow one to achieve economic effect are considered. It is established that the existing mechanism of energy service allows the renovation of buildings with high-quality engineering support and high thermal protection of the shell.

## 1 Introduction

Nowadays, issues concerning improving the energy efficiency of the national economy are considered in the scientific literature as one of the most important aspects of quality of energy systems and attract the attention of an increasing number of scientists [1-5]. The results of numerous studies of foreign [6-10] and Russian scientists [11-14], performed in recent years in the field of energy economics, indicate that energy-service contracts, which have proven to be effective in world practice, are of particular importance. In Russia, the active implementation of energy service contracts continues, the mechanism of which is one of the most efficient types of public-private partnership. At present, experience has been gained in the implementation of energy service measures; there are regions that are leaders in terms of the number and volume of contracts concluded.

Yakutia is the largest region of the Russian Federation, while the population density is only 0.31 people/m<sup>2</sup>. Table 1 shows the main climatic indicators of the republic in terms of territorial location [15]. The considerable duration of the heating period, a significant drop in the internal and external air temperature, and modern requirements for the tightness of the building envelope create particular difficulties for ensuring human activity in the North [16].

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**Table 1.** Indicators of the heating period of residential areas.

Residential area	Temperature of the outside air in the cold period, °C	Duration of the heating period with daily average temperature not more than +8 °C, days	Average temperature of the period with daily average temperature not more than +8 °C, °C	Degree-day of the heating period at $t_{out}=20$ °C
The Central Yakutia				
Yakutsk	-54	256	-20.6	10650
The Eastern Yakutia				
Oymyakon	-60	286	-24.3	12956
Yst'-Nera	-58	272	-25.6	12186
The Southern Yakutia				
Neryungri	-45	270	-16.5	10125
Aldan	-42	267	-13.3	9158
Lensk	-49	259	-14.2	9117
The Northern Yakutia				
Tiksy	-44	365	-13.4	12556
The Western Yakutia				
Mirnyi	-50	264	-15.8	9715

Basing on the climatic features of Yakutia and the data presented in the articles and reports, we state the following objectives: to consider the practice of implementing energy service contracts, to consider their advantages and disadvantages, to identify problematic issues and propose solutions to them.

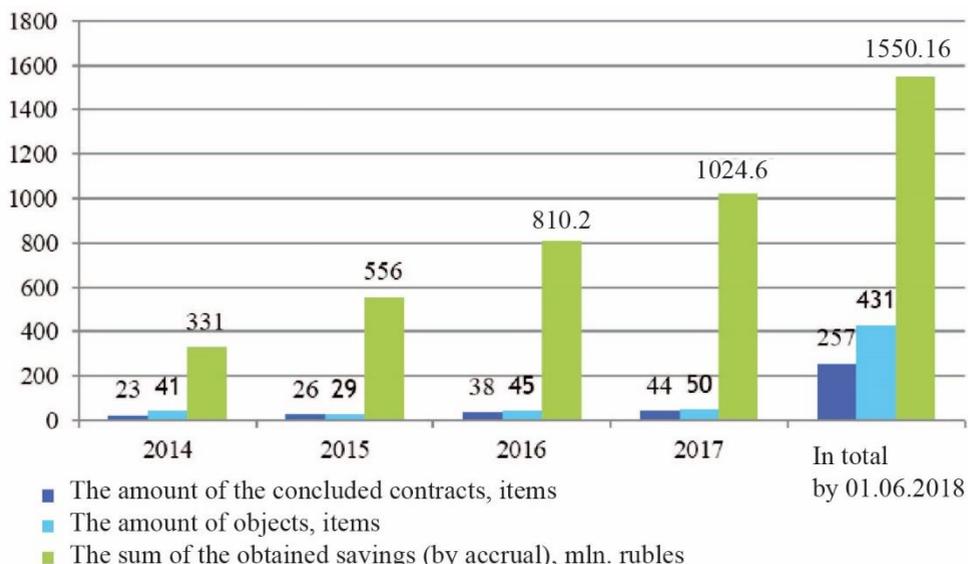
## 2 Methods

A total of 493 energy-service contracts with a total price of 17,484.9 million rubles were concluded in Russia in 2017. The regional distribution of contracts is fairly even, while the Sakha Republic (Yakutia) is the clear leader in terms of market volume, and the Smolensk Region is the leader in terms of the number of the concluded contracts. The analysis shows that the subject of more than 60% of contracts is the conservation of heat energy, 36% are dedicated to the electricity conservation. The price of contracts varies in the range from 190 thousand rubles up to 4.4 billion rubles, which indicates the scale of the projects [17].

Currently, in the Republic of Sakha (Yakutia), the state continues to pursue energy conservation and energy efficiency. To date, 257 energy-service contracts have been concluded in 22 municipalities, covering 431 objects, including: 23 apartment buildings, 383 public sector institutions, 20 boiler houses, 1 conduit and 4 street lighting systems. Contract executors invested from their own funds for the implementation of energy-saving measures of 1,077.7 million rubles. In fact, the resulting savings amounted to 1,550.16 million rubles, while the total specified amount of savings under contracts was 2,406.9 million rubles.

Currently, in the Republic of Sakha (Yakutia), there are 156 energy-service contracts taking into account completed and terminated contracts. The dynamics of implementation of these contracts is presented in Fig. 1. It can be seen from the figure that the contract volumes increase every year, while the savings achieved by accrual for 2018 compared with 2014 are

4.5 times more. The planned amount of savings from the implementation of these contracts is more than 1.6 billion rubles.



**Fig. 1.** Dynamics of the energy-service activities in the Republic of Sakha (Yakutia)

Introduction of energy-service contracts in 2011 began with budgetary enterprises of the republic, while the main goal was to provide enterprises with financial resources and routing of their actions, which guarantees a return on investment to the contractor. Table 2 presents indicators for various sectors where energy service activities are currently performed.

**Table 2.** Energy service activity by sectors (all contracts as of 01.06.2018)

Name of indicator	Object types					
	Apartment building	Budgetary institutions	Boiler houses	Street lighting systems	Conduit	Total
Amount of objects	23	247	19	1	1	330
Attracted investments at the expense of performers, mln. Rub.	140.06	415.75	285.97	106.8	129.15	1077.7

The largest amount of investments and contracts is accounted for the budget sector and the system of thermal generation. This factor proves that energy service companies are interested in guaranteed return of investments and profit from savings.

Figure 2 shows the volume of thermal energy in Gcal, in rubles for 2017 for budgetary institutions and apartment buildings that are not covered by energy service contracts.



**Fig. 2.** Potential of the energy-saving market

At the same time, the republican budget expenditures for reimbursement of expenses for payment of heat energy, taking into account subsidies to the utility sector and the population reach 22.32 billion rubles for the year 2017.

Today, despite the existing problems in the renovation and maintenance of existing buildings and facilities of the public sector, there is great interest among a wide range of market participants. The energy service mechanism acts as a tool for modernization of thermal protection and engineering systems for buildings with a decrease in operating costs and the load on the state budget. One of the leaders in the implementation of energy service contracts in the RS (Y) is the enterprise LLC “Energoberegayushchiye Tekhnologii”, which was formed in 2010. Currently, the company has implemented contracts at 161 objects in 6 districts of the RS (Y). Thus, within the framework of the energy service contract, the following set of measures was performed:

1) Replacement of the old worn heating networks and internal engineering systems. In the course of the work, the company has applied modern innovative technical solutions to increase the durability, reliability and efficiency of the systems. So for example, for the first time in permafrost conditions, energy-efficient underground pipelines were used in a large volume. Pre-insulated polymer pipelines with heat insulation from polyurethane foam on a rigid basis with a service life of 50 years (Fig. 3) were applied. At the same time, due to usage of an effective heat-insulating material, the process of thawing of permafrost soils is prevented.



**Fig. 3.** Laying of the pre-insulated polymer pipes for heat supply networks in the village Namtsy (Namsky district)

2) Thermal insulation of external enclosing structures up to the required standards of SP 50.13330.2012 using high-performance thermal insulation materials: mineral wool boards of M75-125 grades, spraying two-component foamed polypropylene on a rigid basis. At the same time, the requirement of installation of structures with minimization of “thermal bridges” is fulfilled [18-23].

3) Replacing old window constructions with wooden frames with modern PVC windows with spraying, as well as door constructions that meet the required standards SP 50.13330.2012.

4) Installation of Danfoss automated control units with weather control. Automated heat points allow optimizing the supply of heat energy to the heating, ventilation and hot water supply systems depending on changes in the outdoor air temperature.

5) Installation of thermostatic valves for heating devices with automatic control.

6) For the technological and commercial energy metering, the dispatching system “LERS ACCOUNTING” and automation of heat supply points and input units are installed (Fig. 4). The introduction of a dispatching system increases the efficiency of emergency services, reduces the costs of payroll, allows one to obtain in-depth analysis to make correct and accurate decisions.



**Fig. 4.** Dispatching office of LLC "Energoberegayushchiye Tekhnologii" for remote control of energy consumption systems

- 7) Replacing the lighting systems with modern energy-saving lamps, with motion sensors.
- 8) Modernization of thermal generation systems with the replacement of boiler equipment, automation systems, accounting and control of thermal energy.

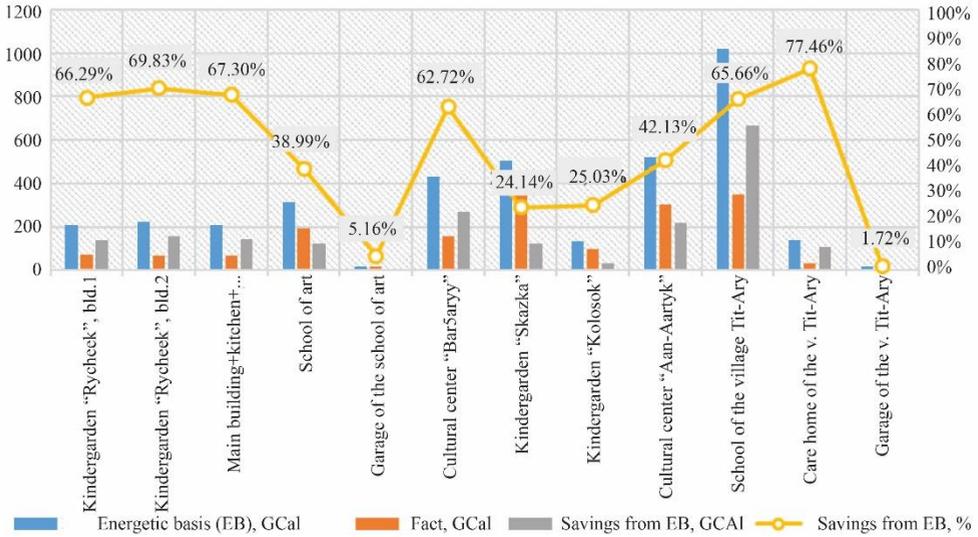
### 3 Results and Discussion

The economic efficiency of investing in energy-saving measures is directly dependent on the cost of energy. Obviously, the higher is the cost of energy, the faster the payback of the applied technical solutions to reduce the energy consumption of buildings is [24].

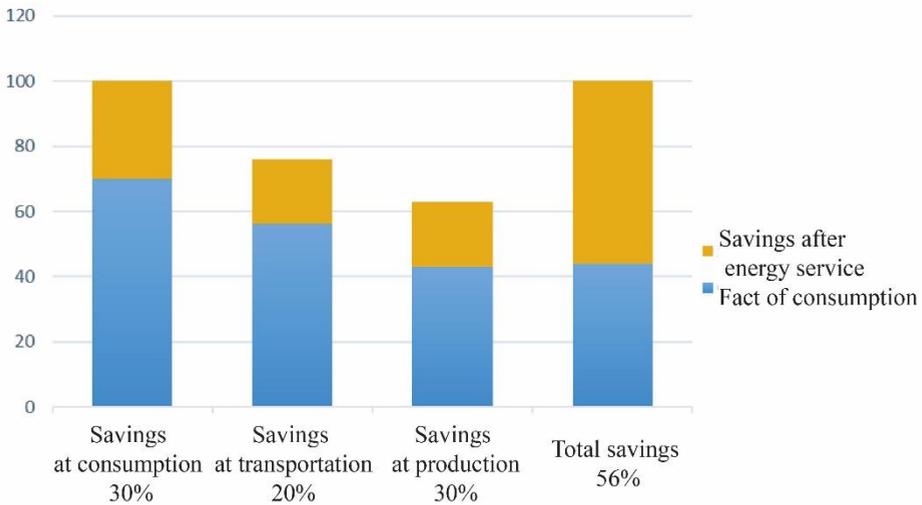
Figure 5 shows the dynamics of heat saving by budget institutions of the Khangalassky district of the RS (Y) for 2017, obtained after energy service activities. As it can be seen from the chart, the savings rates vary greatly from 1.72% to 77.46%, which depends on the size of the building, as well as technical and economic characteristics. The average savings on objects is 52.94%.

Next, Figure 6 shows the dynamics of heat energy savings in the context of the Supplier-Consumer scheme for all 161 objects of the company "Energoberegayushchiye Tekhnologii" LLC.

As can be seen from Figure 6, the greatest savings occur at consumption of resources by the consumer. In this regard, it is necessary to clarify that when planning and implementing energy-saving measures in the budget and housing sector, more attention is paid to saving thermal energy as the final result. This factor is due to sharp differences in the cost of the tariff for thermal energy, which varies from 2002.0 rubles/Gcal in the city of Yakutsk to more than 20,000.0 rubles/Gcal in the districts. At the same time, 90% of public sector facilities in rural areas of the republic have wooden buildings with low thermal protection and old engineering networks. Based on this, during the implementation of complex measures the greatest economic effect is achieved, which ultimately becomes a source of return on investment, a comfortable environment for consumers arises and the security and reliability of the energy supply as a whole is ensured.



**Fig. 5.** Indicators of heat energy savings in the Khangalassky district in 2017



**Fig. 6.** Indicators of heat energy savings in the context of the thermal energy usage

## 4 Conclusions

Prospects for energy service in Yakutia:

1) It is seen from Figure 2, that there is a high potential for energy saving in the sector of multi-family housing construction (MFH). At the same time, in order to be able to implement the energy service in the MFH, it is necessary to improve federal and regional regulatory acts, including the system for the overhaul of buildings.

2) Energy service is proposed to be used as a tool for implementation of alternative energy sources, for example, in Yakutia it is solar energy. The intensity of solar radiation in Central Yakutia makes it possible to introduce and operate a solar collector for hot water and heat supply systems. Thus, the total solar radiation in the city of Yakutsk is 3,483.1 MJ/m<sup>2</sup>, of which 1929.9 MJ/m<sup>2</sup> is radiation on a horizontal surface. For comparison, the calculated

value of direct solar radiation on a horizontal surface according to data in Astrakhan in March is 372 MJ/m<sup>2</sup>, and in Moscow in October it is 145 MJ/m<sup>2</sup>. In other regions of the Russian Federation it is possible to use thermal sources and wind energy. Today, alternative energy sources are developed all over the world, but their use in the conditions of the Far North is difficult. It's usage as a separate autonomous source of energy is impossible because of the high cost of equipment, the inconstancy of the sun and wind. In this regard, it is proposed to use alternative energy sources in dual engineering systems, taking into account the real savings in energy consumption.

3) Today, factoring in the energy service sector is additionally required for further development. Factoring is a financial instrument when an energy service company, giving the right to a cash claim to a factoring company, remains the contractor, while receiving "future" income from energy savings by a discount, without waiting for the end of the contract period. This financial mechanism allows the company to repay borrowed funds and participate in new projects. Provided that when large credit funds in the region are exhausted, the use of the factoring mechanism of energy services in apartment buildings is relevant.

4) During implementation of the energy service we identified problematic issues that need to be addressed. The main problems in the region are:

- Insufficient accounting of consumed energy resources due to low equipment by energy meters. So, the housing stock is equipped by all devices for 41.2 - 61.9%, the public sector for 57.4 - 96.6%, thermal generation systems (boiler houses) for 26%.

- Growth in tariffs for energy producers while reducing net supply.

- Imperfection of financial mechanisms and regulatory framework for energy service, including regulating the relationship of the Supplier and the Consumer in the commercial accounting of heat energy.

- There is no mechanism for timely annual delivery of heat metering devices to the heat supply organization, which distorts actual energy saving indicators. Energy service indicators are becoming dependent on the actions of the equipment acceptance inspector, and it is necessary to take into account the short inter-heating season of work.

5) It is necessary to organize a centralized management system in the sector of housing and communal services and create a single information space, based on the actual consumption of utility resources according to metering devices.

So, on the issues discussed, the following conclusions can be made:

1. The energy saving potential due to heat energy in Yakutia, based on these parameters, is 2.232 billion rubles/year at a minimum total savings of 10%.
2. The dynamics of development of energy service contracts in RS (Y) is increasing every year for 20-40%. The achieved savings from the energy-service implementation is 1.5 bln. rubles.
3. The main energy saving measures at the energy service facilities in the region are aimed at reducing the consumption of thermal energy, which is associated with the high cost of the tariff, low thermal protection of buildings and high wear of engineering systems. At the same time, the return on these measures is higher than in other energy-consuming systems. Thermal insulation of enclosing structures to the required building standards and proper automation of systems provide savings of up to 70%.
4. The ultimate goal of energy service is not only to save energy resources, but also to create and maintain a comfortable microclimate in buildings. A major role in the implementation of energy saving measures is played by the preparatory stage: work planning, investment attraction and competent energy audit.

The practice of energy service sales in the Republic of Sakha (Yakutia) has shown its effectiveness in attracting extra-budgetary investments, introducing new technologies, modern materials, and digital technologies. Attracting advanced companies to the republic,

world leaders in the field of energy efficiency, will allow one to raise the level of projects, allow to use even more technological, reliable and efficient equipment and materials.

The savings achieved at the same time will significantly reduce the budget burden for the maintenance and operation of buildings in subsequent years.

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