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Modern Tools for Sustainable Development of Territories. Special Topic: Project Management in the Regions of Russia

ENERGY EFFICIENCY AS A MUNICIPALITY BUDGET SAVING

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Abstract

The article discusses the development of energy conservation of cities, as a way to reduce the costs of municipal budgets and support the environment. The study examines solutions for upgrading the city's lighting infrastructure, models of energy service contracts, problems and risks of energy service contracts. Contracts are being investigated as an important tool of municipal management and cooperation with business. The main question of the study is to answer the questions: is it always necessary to use such a model for solving energy saving and updating the city's lighting infrastructure and what alternative development directions exist? The article used the method of theoretical analysis and synthesis of scientific and methodological literature, regulatory documents, observation, methods of mathematical analysis and statistics. To consider solutions for energy saving in the city and reducing budget expenditures in the current modern conditions, the situation in the tourist city of Russia was studied. A modern example and directions for making energy saving in the city with maximum effect for the municipal budget are also considered. Highlighted the need for flexibility of contracts to the rapid changes in technology in this area and possible alternatives. Attracting investments in energy-saving technologies of the city infrastructure can be a very effective and quick way to reduce the costs of the municipal budget. Management and careful consideration of the contract system of the municipality is a very important tool for municipal management, city development and creating opportunities for sustainable development of the territory together with business.

Keywords: Energy efficiency, energy service contract, municipality budget, risks.

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1. Introduction

In the modern world, there are two urgent problems - this is the ecology and the quality of life of the population. These problems in cities also depend on municipal budgets.

A significant proportion of the energy consumption of modern cities in Russia is the cost of city illumination. These include illumination of premises, illumination of city streets, architectural lighting of city objects, and illuminated advertising. This type of expenditure is of particular importance for tourist cities, in these cities the income from tourism is significant. And the illumination in these cities is often part of the tourist product (Vorobey & Borisova, 2018), and sometimes the calling card. What also has an impact on the ecology of the territory, city, and ecological status of the city for tourists (Balabanova, Keschyan, Borisova, & Hachemizova, 2019).

At the same time, in many cities of Russia, modern technologies in illumination are still insufficiently applied. To reduce the cost of lighting is possible through the use of new energy-saving lighting devices. But the question arises about the sources of investment.

2. Problem Statement

In Russia, problems with energy efficiency have been actively addressed through the system of energy service contracts. In the past few years, legislation has been developed and adapted for this system. Only in the first half of the year tenders were announced and held in the section of energy service contracts for 5,383.4 million rubles on the "RosTender" Internet site (http://rostender.info).

Almost all contracts are long-lasting, but the conditions are different: the percentage of savings, responsibility, duration of service, warranty and the life of lighting devices. In the modern world, the pace of changes in technology, market, and the requirements of cities is increasing every year, which makes such commitments rather inflexible. As well as the scale and relevance of these decisions in the future, this was the reason for considering this model of solutions in more detail and with a specific example.

3. Research Questions

The main question of the study is to answer the questions: is it always necessary to use such a model for solving energy saving and updating the city's lighting infrastructure and what alternative development directions exist?

So, the answer to the question "What motivates local authorities to conclude contracts for improving energy efficiency for modernization?" Reveals in the article of Friedemann Polzinab, Paschen von Flotowb, Colin Noldenc, on the example of German municipalities. This article highlights the goals of municipalities: mitigating the effects of climate change through the introduction of new technologies, improving energy efficiency. As well as problems: budget and staffing constraints. As a solution to the problem, the direction of contracts for energy services is being studied. This document reports on the results of a survey of 1,298 municipalities regarding obstacles to modernizing public street lighting and the possible role of entering into contracts with energy services to overcome these obstacles. The results of the study point to the advantage of outsourcing in conditions of limited financial and production potential, which corresponds to the main reasons for participation in contracts: minimization of

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investments and financial risks (Polzinab, Flotow, & Nolden, 2016). As research on solving problems of energy conservation through energy service contracts shows, the question is not unambiguous.

In different countries, depending on the legislation, (Carbonara, 2018) models of public-private partnership are being developed for energy efficiency projects and models for choosing the structure of energy-efficient contracts (Shang & Zhanga, 2017). For example, game-theoretic methods, non-cooperative scenario, models of cooperative games (Liu & Zhang, 2019) are used.

Also, regarding the Russian market, there are many modern studies (Garbuzova-Schlifter & Madlener, 2016) that examined the main risk factors and causes of risk associated with these contracts, problems in EPC projects, regulatory and financial risks (Jackson, 2010).

4. Purpose of the Study

The purpose of this research is to review and compare the directions of solutions for energy saving lighting of the city to save budget funds in the current modern conditions for resort cities of Russia.

5. Research Methods

The article used the method of theoretical analysis and synthesis of scientific and methodological literature, regulatory documents, observation, methods of mathematical analysis and statistics.

To consider solutions for energy saving in the city and reducing budget expenditures in the current modern conditions, the situation in the tourist city of Russia was studied. For the city is characterized by the use of street lighting, park and architectural. Illumination of city streets requires significant budgetary appropriations. But work is underway to create a greater street performance.

An energy service contract is a contract for the introduction of energy-saving technologies, the subject of which is the implementation by the contractor of actions aimed at energy saving and increasing the energy efficiency of the use of energy resources by the customer.

The essence of the agreement lies in the fact that it involves the implementation of a complex of works by the energy service company on the implementation of energy-saving technologies at the customer's enterprise at the expense of the energy service company.

The economic peculiarity of the contract is that the payment for the attracted financial resources and the work done by the energy service company are made by the customer after the project is implemented with funds that make up the economic effect of the introduction of energy-saving technologies.

There are several types of energy service contracts: Shared Savings, where there is a division of income from savings; First-Out, Fast Pay-Out, where the main point is quick payback; Guaranteed Savings Chauffage - guaranteed savings.

The terms of the contract are conditionally divided into mandatory and recommended. The parties must agree on the amount of energy savings that must be provided by the Contractor as a result of the execution of the contract.

The main parameters of the proposed energy service contract for the city:

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- to achieve an average level of illumination based on the average brightness of improved coatings and the average horizontal illumination of coatings according to the Classification of the road network of urban settlements;
- to achieve a reduction in electrical energy consumption during the operation of street lighting facilities in the city.
- carry out activities in accordance with the specifications and instructions of manufacturers of equipment.
- replace the existing street lamps with LEDs in the amount of 9,876 pieces;
- replace the lamps in the existing street lamps of the park (ball) type with LED in the amount of 1939 pieces, if necessary, upgrade the existing lamps;
- to ensure the quality of services rendered (work performed) in accordance with the applicable building codes and regulations, state standards of the Russian Federation in the field of construction and overhaul, electrical installation rules, requirements of fire safety authorities and other applicable standards, and technical conditions;
- the contractor undertakes to carry out activities that will allow, as a result of the fulfillment of the energy service contract, to ensure the amount of electrical energy savings annually at least 62% of the volume of energy resource consumption (electrical energy) for the base period.
- guarantees for materials and equipment are provided to the Customer from the date of signing by the Parties of the acceptance certificate of completed work for a period of 7 years, but not less than the deadline of the manufacturer.
- the contractor is responsible for the quality of energy-saving fixtures during the warranty period in accordance with the contract.

Energy efficiency measures include: replacement of existing street lighting with LED (energy efficient) in the places of their installation in the city; replacement of lamps in the existing street lamps of the park (ball) type with LED (energy efficient) in the places of their installation in the city.

We calculated the cost of service in case of marriage. According to the specified technical requirements for lighting devices, we calculate the average cost per luminaire based on the average market value - 6,555 rubles. The market value of replacement services is 1000 rubles.

We will calculate the possible expenses of the Customer, provided that the first 7 years, even the replacement and maintenance takes place at the expense of the Contractor. For the number of hours of operation per year of instruments we take the national average - 4380 hours per year, i.e. if it is 12 o'clock dark time in a day, it is even an overestimated figure for this region.

The service life of lamps in the retail market, which was taken to calculate, used lamps with a margin of 100,000 hours, this should be enough for 20 years. But the contract does not specify the minimum amount of service life in hours for all categories of luminaires, which already carries certain risks, but in those positions where it is indicated - they were 10,000 hours, which should be enough for 2 years of operation.

A period of 10 years was taken for calculation, on the assumption that the Contractor will purchase equipment for at least 50,000 hours. Dismantling and installation of lighting cost 1000 rubles per object.

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Prices correspond to the retail market, that when purchasing in bulk and, accordingly, installation and dismantling services, will only reduce the cost of the considered solutions. Next, we take into account the cost of the lamps, which we took to calculate the cost, and what savings they give. The current consumption for the year was 8594336 kWh, we calculate the average for one lighting device, taking into account 4380 hours of dark time per day for the year. The calculations were not taken into account, but provided for in the contract: possible wholesale cost of equipment; the cost of operating the current equipment, its scrap, and maintenance; change in the cost of electricity, inflation and so on.

The cost of raising funds on credit was also calculated to account for a contracted variant in which the Contractor only provides equipment and installation with installation warranty, and the equipment warranty comes from the factory (Table 01). On the equipment we offer, which is offered at retail, the warranty ranges from 5 to 7 years and the service life is from 70,000 to 100,000 hours.

Table 01. Cost of borrowed funds for the purchase and installation of equipment at retail prices

Credit	First year	Second year
Loan rate, %	20%	20%
Amount of debt, rub.	89 261 500	49 042 585
Cost at 20% per annum, rub.	14 297 514	5 473 843

We will calculate the possible expenses of the Customer, provided that the first 7 years, replacement and maintenance takes place at the expense of the Contractor, that is, if under the terms of the contract it has been serving for 7 years. And the Contractor has losses for marriage, and the savings should be at least 62%. In the retail market, at the price taken for the calculation, lamps are used with a margin of 100,000 hours, which in theory should be enough for 20 years. But in the contract, if only a 7-year warranty is indicated, the probability also remains that the service life of the lamps may also be 7 years, and then it will be necessary to purchase again. It is desirable if the contract will indicate the stock from 50,000 to 100,000 hours. For the calculation we will take a period of 10 years, based on the assumption that the Contractor will purchase equipment for at least 50,000 hours (Table 02). Dismantling and installation of lantern lighting costs 1000 rubles.

Table 02. Cost of decisions on the provision of lighting for 10 years, thousand rubles

№	Costs	Total	Percentage ratio to option 1 (model 1)	Contract Model 1	Percentage ratio to option 1 (model 2)	Contract Model 2
1	No contract	598 596 362	100%	598 596 362	100%	598 596 362
2	Contract Model 1 (10% Reject)	544 459 125	91%	514 036 136	86%	544 459 125
-	30% of marriage	589 090 287	98%	567 593 531	95%	589 090 287
3	Contract Model 2 (10% Reject)	284 931 551	48%	284 931 551	48%	284 931 551
-	100% replacement after 5 years	329 562 714	55%	329 562 714	55%	329 562 714
-	30% of marriage	323 611 892	54%	323 611 892	54%	323 611 892
4	The cost of a loan to purchase equipment	19 771 357	3%	19 771 357	3%	19 771 357

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When operating equipment for 10 years, this contract with a minimum marriage of 3% is effective, but with a marriage of more than 30% after the expiration of the manufacturer's warranty, the cost becomes more expensive. That is, if during the next 5 years of operation all the equipment has to be changed, the result from the contract for 10 years will be 5% (Figure 01).

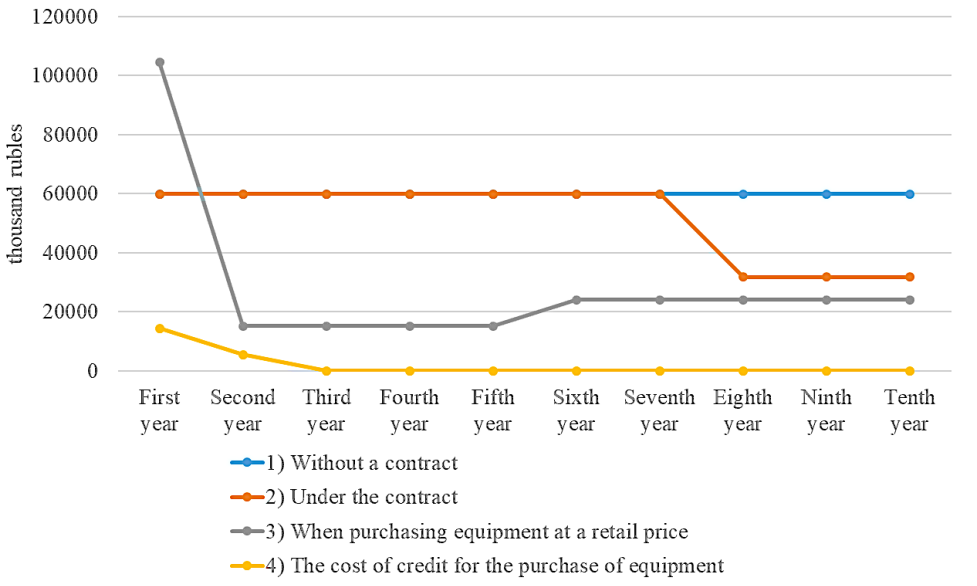

Figure 01. Options for the cost of providing lighting for 10 years (short version), thousand rubles

The contract, in which equipment and installation services will be purchased even at retail prices and equipment warranty - 5 years, will be more efficient than the contract in question at any level of defects, and 44% more efficient on average. Taking into account the use of borrowed funds at a cost of 20% per annum, it is 40% more efficient.

Also, the risks of the second version of the contract are minimal, since the guarantee of the plant in the equipment under consideration is at least 5 years (up to 7 years for some types), and even with 100% replacement of equipment after 5 years, this contract will reduce costs by 55% from the current, calculated on the basis of 2018 (Figure 02).

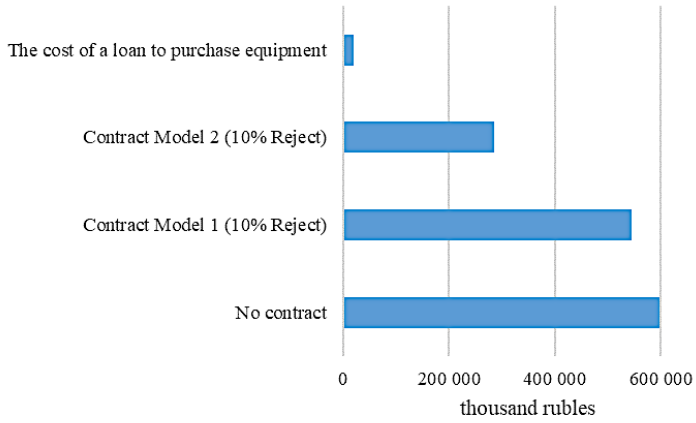

Figure 02. Budget savings over 10 years as a result of decisions (10% of marriage)

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If we take into account the cost of equipment even at retail market prices and operating characteristics that are offered on the market, the kWh consumption can be reduced by 75%.

6. Findings

If in the contract if only 7 years warranty is indicated, the probability also remains that the lifetime of the lamps may be the same 7 years, and then it will be necessary to purchase again. It is desirable if the contract will specify the equipment workload from 50,000 to 100,000 hours, then it makes sense to consider the result for 10 years, if not, then there is no difference, and after 7 years full retooling will be necessary.

But the savings in the following years are not great, if the equipment will work longer than 10 years, i.e. preferably 100,000 hours, then this contract becomes more attractive.

The contract, in which equipment and installation services will be purchased even at retail prices with an annual marriage of 10% and a borrowing cost of 20% per annum, will save 293,893,454 rubles over ten years or 29 million rubles a year.

As mentioned above in the study we are considering, the main reasons for concluding energy efficiency contracts are: minimization of financial risks; minimization of staff; minimization of risk.

Previously, there was high uncertainty regarding the payback period of energy efficiency projects may be aggravated by volatile energy prices and unpredictable energy market regulation, etc. (Hannon, Foxon, & Gale, 2015). But modern technologies improve the quality of production and stability of work, and even Russian manufacturers offer a factory warranty of 7 years and a service life of 100,000 hours, which significantly reduces risks and simplifies the process of operation.

Also, personnel problems arise in the provision of contracts and their competent management, and the risks of loss are also great under the contract system, especially if there is weak management in the city.

There are also risks of energy service companies (Lee, Lama, Yik, & Chan, 2013): the risk of providing the customer with inaccurate and/or incomplete information both at the stage of energy audit and at the stage of operation; the risk of unskilled customer operation of energy-saving equipment; the risk of insolvency of the customer.

7. Conclusion

In the example we have considered, the decision to independently organize and attract even expensive borrowed funds was 40% more efficient or about 240 million rubles than the energy service contract. This decision will allow saving 29 million rubles a year for the budget already in the 3rd year of the project. In modern conditions, flexibility, speed, the efficiency of projects is significant. For example, this amount is 7% of all social expenditures of the municipal budget of this city in 2019. And for the protection of the environment in this budget in 2019 allocated only 3.7 million rubles. Also, this amount of funds is comparable to the number of funds allocated to programs for the youth of the city.

In this example, a high percentage of savings is due to the very old installed current equipment, but also in many more territories. The proposed solutions have the advantage due to a faster payback period

under the contract, and the problem of personnel can be solved by the resulting savings, which will improve the professionalism of municipal organizations, the effectiveness of their activities and, accordingly, the effectiveness of the municipal budget.

The need to create more flexible models in this matter and shorter contracts still lies in the speed of development of modern technologies. For example, the emergence of 5G networks will facilitate set-up and control, systems with solar batteries are becoming more and more efficient, systems based on blockchain technologies are developing, an environmental impact calculator (Mourtzis, Boli, Alexopoulos, & Różycki, 2018), energy demand management and others are proposed.

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