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Features of Cost Advantages from Implementation of Energy-Saving Projects

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ABSTRACT

The implementation of the tasks envisaged by the National Security Strategy provides for the creation and implementation of projects aimed at the formation of the appropriate infrastructure of the regions. The most important component of the regional infrastructure is the energy one, which ensures the solution of urgent problems of the population and enterprises of the regions in obtaining energy and heat supply services. The achievement of the abovementioned goal is provided by introduction of investment projects, the implementation of which makes it possible to obtain cost advantages by consumers of services. Analysis of these projects' implementation programs over a long period of time confirms the significant cost advantages, the importance of which is determined by its social significance. The purpose of this paper is studying issues aimed at analyzing, assessment and shaping the cost benefits of the introduction of energy-efficient innovative technologies for heat-saving at enterprises of the public utilities sector. The study methods for this issue include the cost-benefit analysis, the cost efficiency assessment, tabular and graphical methods, which allow visualizing the structure of the economic effect and identifying its features. The paper presents the structure of the cost advantages gained by consumers that introduce innovative energy-saving technologies. The study revealed the features of the cost benefits formation, their structure, characteristic of these technologies. The paper draws a conclusion about the effectiveness of these projects, confirmed by the results of calculations, for consumers of services. Materials of the article are of practical value for professionals engaged in analysis and evaluation of energy/heat conservation projects, as well as for organizations that implement project outputs when comparing future benefits and costs as opposed to alternative technologies.

Keywords: Cost Advantages, Cost Benefits, Cost Advantage Assessment Method, Energy Security, Energy Saving, Heat Saving, Project Costs and Results
JEL Classifications: D24, Q43, M31

1. INTRODUCTION

The Federal Law of the Russian Federation dated 23.11.2009 No. 261-FZ (2009) "On energy saving and improvement of energy efficiency, and on amendments to certain legislative acts of the Russian Federation" presents the main concepts reflecting the efficiency of energy-saving technologies implementation. Introduction of these technologies provides the user of energy conservation facilities with cost benefits, which are expressed in saving energy and heat resources, reducing heat losses, and hence providing the user with cost benefits.

According to the above-mentioned law, "energy saving" is interpreted as the implementation of legal, scientific, technical, organizational, technological, economic and other measures aimed at effective (rational) use (and lean consumption) of fuel and energy resources under the existing advantageous effect of their implementation, as well as commercialization of renewable energy sources (Federal Law No. 261-FZ, 2009). The Law also defines another key concept - energy efficiency, which describes the ratio of results from the use of innovative energy-saving products to costs, which leads to this effect (result) (Federal Law No.261-FZ, 2009).

Introduction of energy and heat saving projects become particularly important after introduction of the Economic Security Strategy (The Strategy of Russia's Economic Security for the period until 2030, 2017), where energy security is defined as one of the factors ensuring the national security of the state, which is presented in Russia's national security strategy (The National Security Strategy of the Russian Federation until 2020, 2009).

The importance of energy security is also confirmed by implementation of the Energy Strategy of Russia for the period until 2030 (2009), which emphasizes the necessity of developing the country's domestic energy markets, and "programmes of heat supply development to cities of the region" (The Energy Strategy of Russia for the period up to 2030, 2009).

It's worth mentioning that in a number of regions of the Russian Federation there are successful practices of heat-saving projects implementation, which have confirmed their high efficiency of their use at the consuming end. For example, there are successful measures underway to improve energy efficiency in the Republic of Tatarstan based on the Resolution of the Cabinet of Ministers of the Republic of Tatarstan No.653 dated 13.08.1997 "On measures for the development of energy conservation in the Republic of Tatarstan" (Resolution of the Republic of Tatarstan dd. August 13, 1997 № 653, 1997), which are mentioned in documents, such as the long-term grant programme "Energy conservation and energy efficiency improvement in the Republic of Tatarstan for the years 2011-2015 with outlook to 2020" (Long-Term Programme, 2010) and the "Energy conservation and energy efficiency improvement in the Republic of Tatarstan for the years 2014-2020", approved by the Resolution of the Cabinet of Ministers of the Republic of Tatarstan dated December 4, 2013 (Resolution of the Cabinet of Ministers of the Republic of Tatarstan dd. December 4, 2013 № 954, 2013).

The current Long-Term Grant Programme (2010) "Energy conservation and energy efficiency improvement in the Republic of Tatarstan for the years 2011-2015 with outlook to 2020" presents a mechanism for development of energy saving in public utilities sector and housing stock.

2. LITERATURE REVIEW

The method of determining the cost advantages of measures according to the product utilization conditions is described in the Guidelines (1989) on Comprehensive Assessment of the Efficiency of the Measures Aimed at Accelerating Scientific and Technological Progress in the Oil Industry. Based on these guidelines, the author has developed a technique to justify the efficiency of implementation (introduction) of heat-saving measures (Kvon, 1998), while the calculation data for this and other resource efficient measures summarizing the results of their introduction are presented in the paper co-written with Takhautdinov et al. (1998).

The study of Starodubtseva and Romanova (2018) presents the problems specific to Russian enterprises that utilize energy-efficient technologies. According to the authors, such problems are often caused by the lack of awareness of these technologies and lack of incentives for their introduction. In this regard, we believe it is important to explain the high efficiency of energy-saving technologies used by consumers, the introduction of which provides a source to cover the costs of their introduction.

The importance of the projects' implementation has been confirmed by the studies conducted by the authors within the previous paper (Postalyuk and Kvon, 2014; Kvon, 2018), where, based on the analysis of the Energy strategy of Russia for the period up to 2030 (The Energy Strategy of Russia for the Period up to 2030, 2009), the results of not quite satisfactory condition of energy and heat conservation facilities due to their high wear had been presented.

The paper of Nasyrov (2014) presents the efficiency assessment process for energy conservation projects in industry, based on technical, economic and social and environmental indicators. The author reveals the formation of energy conservation indicators that characterize the activity of a company implementing energy-efficient projects.

Galperina (2011) in her paper presents the principles, methods and stages of implementation of energy saving projects at the stage of investments in project development, but does not specify the utilisation features and calculation methods of energy conservation technologies for end users of these technologies.

The algorithm of implementation of the economic assessment methodology for energy systems in buildings where energy-efficient structures are used is presented in the study of Shibalov (2018). The author suggests using the method of discounted cash flows estimation.

Maksimchuk et al. (2016) and his co-authors present methodical approaches to efficiency evaluation of energy-saving technologies and measures in their paper. The authors carried out a comparative assessment of several approaches to efficiency assessment: Market analysis, two-way analysis of variance, financial analysis. Pros and cons of each approach were determined as a result of critical analysis. The authors come to the conclusion that none of the methods fully meets the requirements for assessing the projects on introduction of energy-saving technologies.

Regional aspects of introducing energy and heat saving measures and assessing their efficiency (using the example of RT) are presented in the proceedings of the XVI International Symposium "energy and resource efficiency and energy saving" in the Republic of Tatarstan (Proceedings of the XVI International Symposium, 2016).

3. METHOD OF DATA ANALYSIS

3.1. Objectives of the Research

The authors addressed the following tasks in the course of the research:

1. Selection of a measure (innovative technology for replacing heat networks composed of polyurethane [PU] foam-coated pipes), affecting the technology users;

2. Justification of the measure's cost efficiency assessment method;
3. Identification of features of cost advantages generation while using thermally insulated pipes;
4. Identification of factors that create the cost advantage;
5. Assessment of each factor's impact on the cost advantage.

3.2. Theoretical and Empirical Methods of Research

Various methods were used in the course of the work:
1. Discounted methods of assessing the cost efficiency of the measure;
2. Comparative assessment methods of the results and costs of measure utilization;
3. Methods of analysis and synthesis;
4. Tabular and graphical methods of calculation results visualization.

3.3. Justification of Calculation Methodology

From the methodological point of view, the cost efficiency (Guidelines, 1989) is the difference in valuation of results and costs over the calculated period, i.e., the duration of the efficiency effect, namely:

$$E_p = R_t - C_p \quad (1)$$

for t_f

$$R_t = \sum R_t \, x \, \alpha_t \quad (2)$$

t_i

$$C_p = C^P{}_p + C^U{}_p, \quad (3)$$

Where E_p is the cost efficiency of using new technology pipes (measure under introduction) over the calculated period;
C_p is valuation of this measure's implementation costs over the calculated period;
R_t is valuation of results in the year t of the calculated period;
t_i and t_f are the initial and final years of the calculated period;
α_t is the reduction factor to reduce benefits and costs of different times to the calculated year;
$C^P{}_p$ *and* $C^U{}_p$ are the costs of (P)roduction (creation) and (U)tilizing of (p)ipes.

Whereas,

$t_f t_f$

$$C^{P(U)}{}_t = \sum C^{P(U)}{}_t \, x\alpha_t = \sum (X^{P(U)}{}_t + K^{P(U)}{}_t - S^{P(U)}{}_t) x\alpha_t, \quad (4)$$

$t_i t_i$

Where $C^{P(U)}{}_t$ is the total cost of production (utilizing) of the measure in the year t;
$X^{P(U)}{}_t$ are current eXpenditures for utilizing pipes in the year t;
$K^{P(U)}{}_t$ are the one-time costs for utilizing the pipes in the year t;
$S^{P(U)}{}_t$ is the scrap value of fixed assets to be liquidated in the process of pipe utilizing in the year t.

Reduction of costs and benefits from different times to a single point of time - the calculated year t_p - is mandatory, should the duration of the calculated period be >1 year. At the same time, the year preceding the commencement of coated pipes utilizing shall be deemed as the calculated year.

4. RESULTS

According to the Ministry of Energy of the Russian Federation (Presentation of the Russian Ministry of Energy, 2016), heat supply is comparable to 2.1% of gross domestic product (RUB 1.5 trillion) in terms of turnover and averages 50% of a citizen's payment for housing and utilities. The major concern stems from the fact that the stable level of capital renewals in the heat supply system (heat networks) is only 4% per annum, and the current renewal rate is only 2.7% per annum. According to the Ministry, the share of heat networks requiring replacement is steadily increasing, as the heat network replacement rate is lower than the obsolescence rate. The above leads to high heat losses, up to 60%, in the heat distribution and consumption area. An alternative to the measure introduction is the construction of heat networks made of insulated pipes. Without dwelling on the advantages of this kind of innovation measures that were covered in detail in the early works of the author (Kvon, 2007; Kvon, 2018), we analyze the structure of the cost advantages in the case of using pipes with polyurethane foam insulation in the public utilities infrastructure.

Modernization of the municipal heat supply system requires the proof of the effectiveness of implementing these measures by consumers. As it has been already mentioned above, the cost advantages can be shown as the difference in the cost estimates of the results and the expenses over the calculation period, i.e., the period of time, in which the technology used is operated by the consumer.

To perform the assessment, the basic and new calculation options shall be identified. As a basic option (the technology to be replaced), heat networks made of pipes with a mineral wool (MW) insulation are considered.

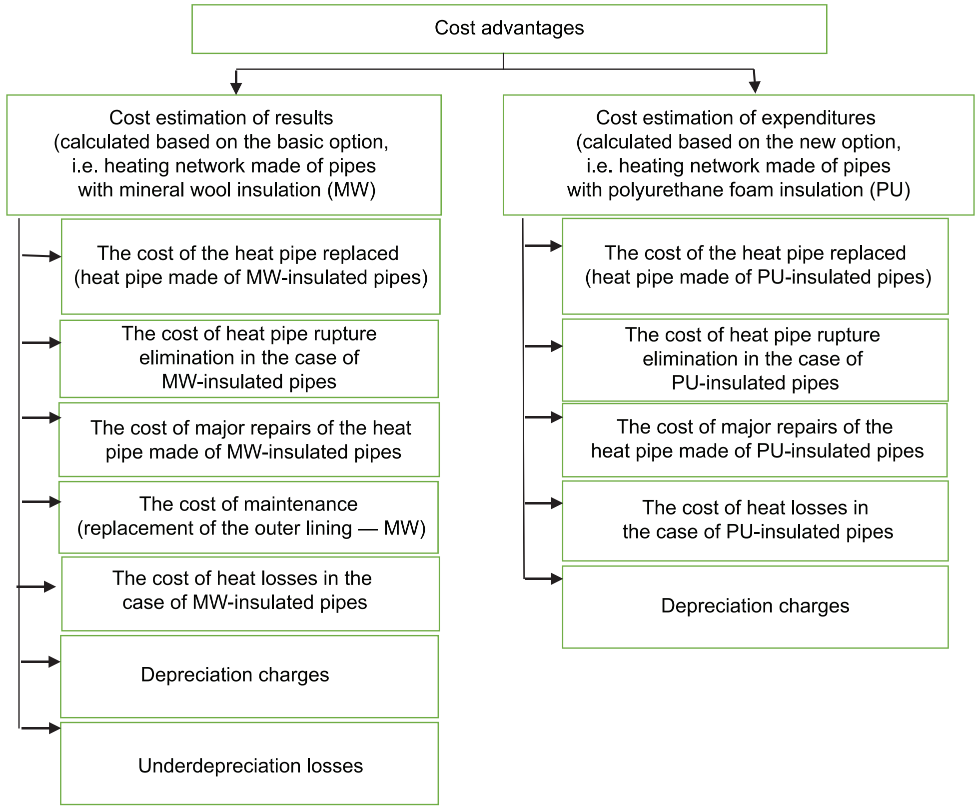
A new option (the technology to substitute the old one) is heating networks made of pipes with PU foam insulation.

Let us consider the peculiarities of the formation of the cost advantages resulting from the use of insulated pipes (Figure 1).

As is seen from the figure above, a number of indicators shown in the results and expenses columns overlap; however, the costs in the new option scenario (in the case of using PU-insulated pipes to build heat networks) do not contain the maintenance costs and under depreciation losses incurred due to frequent replacement of heating systems built using MW-insulated pipes.

The economic essence of the cost estimation of the results is the amount saved per 1 km of a PU-insulated heat pipeline over its lifetime. For the calculation purpose, the estimated service life is taken as 25 years. It is important to note that a PU-insulated heating network has a longer service life (25 years) compared to a heat pipeline made out of MW-insulated pipes (10 years). To

Figure 1: The structure of cost estimates of the results and expenditures in assessing the cost advantages of using polyurethane-insulated heat pipes



this end, the service life plays a significant role in the formation of the cost advantages.

In general, this dependence can be described as the following model:

$$E_T = E_{t=1} + \sum \Delta E_i x\, t_i \quad (5)$$

With $i = 2,3,4,\ldots, T_{SL}$

Where $E_{T=1}$ is the cost advantage (effect) resulting from using the measure during the year of implementation, RUB thousand;
ΔE_i - annual cost advantages for the coming years, i.e., the years following the year of implementation, RUB thousand;
T_{SL} - the service life of a heat pipeline made of PU-insulated pipes (calculation period), years.

For the purpose of the calculation, it is assumed that the use of PU-insulated pipes was compared with MW-insulated pipes.

The cost advantages resulting from the implementation of the measures (the use of PU-insulated heat pipe) consist of two main components:

- Saving of one-time costs for re-construction (replacement of the object MW-insulated heat pipe);
- Aggregate savings of the current operating costs resulting from the elimination of heat pipe ruptures, maintenance, heat loss costs, major repairs, depreciation and underdepreciation losses;

The total amount of the first cost advantage component is determined by the cost of replacement of MW-insulated heat pipe and the frequency of such replacement efforts over the service life of a PU-insulated heat pipe.

Let us take a look at the results of the calculation of the cost advantages granted by the use of PU-insulated pipes in the housing and public utilities. For the convenience of the analysis, the calculations are presented in relative values (Figure 2).

As can be seen from the figure above, the main portion of the cost advantage resulting from the use of the measure (construction of heating networks using PU-insulated pipes) falls on capital costs saving - 53.5%. This means that the replacement of the old technology (heat networks made of MW-insulated pipes) enables the company to reduce further replacements of the heat pipeline during its construction (if PU-insulated pipes are used).

Current operating costs account for 46.5% of the size of cost advantages. Of these, the main portion of savings falls on the reduction of heat losses when using the new heat network construction technology (23.2%), depreciation - 8.9%, as well as the elimination of under depreciation losses (6.4%), as there is no need for further replacement of heat pipelines and no losses arise from writing-off the under depreciation amount from the company's profits.

The cost advantages are generated over the years of the calculation period (25 years) unevenly: The main portion of the advantages falls on the years of replacement of MW-insulated heat pipes with PU-insulated pipes (Table 1).

Figure 2: Components of the cost advantages resulting from the use of polyurethane-insulated pipes in the housing and public utilities.

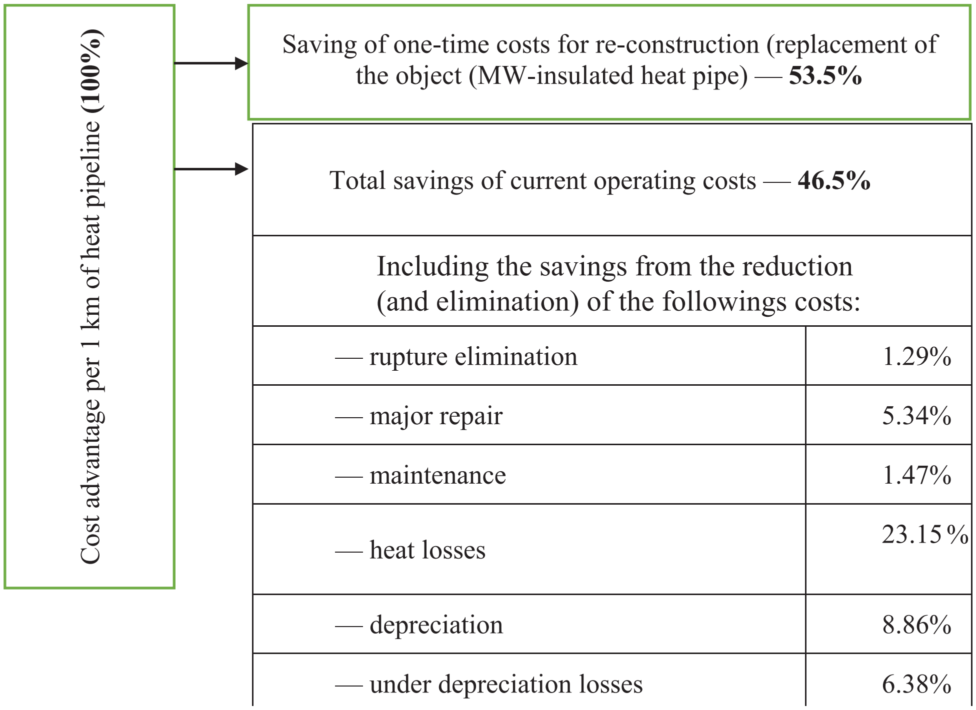


Table 1: Formation of the cost advantages resulting from the use of PU-insulated pipes

Years	Cost advantages		Years	Cost advantages	
	By the years of the calculation period (%)	Accumulative (%)		By the years of the calculation period (%)	Accumulative (%)
1	21.4	21.4	14	1.1	86.2
2	4.4	25.9	15	1.0	87.2
3	4.0	29.9	16	0.9	88.1
4	3.7	33.6	17	0.8	88.9
5	3.3	36.9	18	0.7	89.6
6	3.0	39.9	19	0.7	90.3
7	2.8	42.7	20	0.6	90.9
8	2.5	45.2	21	7.4	98.3
9	2.3	47.5	22	0.5	98.8
10	2.1	49.5	23	0.5	99.2
11	32.7	82.3	24	0.4	99.7
12	1.7	84.0	25	0.4	100.0
13	1.2	85.1		100	

PU: Polyurethane

According to the report of the Government of the Republic of Tatarstan (Summary Report, 2018), the modern pipes used for heat supply account for 10% in Russia and 47% in the Republic of Tatarstan. It should be noted that in 2017, the Ministry of Energy of Russia, together with the expert community and regions, for the first time formed a heat supply efficiency rating for the constituent entities of the Russian Federation. In this regard, the successful experience of the region should be shared across other constituent entities of the Russian Federation.

5. CONCLUSION

The urban public utility providers face the tasks of ensuring timely and high-quality heat supply to residential and industrial premises. In turn, this requires the introduction of advanced technologies allowing to minimize heat losses in the process of heat distribution and transmission. The introduction of insulated pipes allows bringing this type of service to a whole new level: Their use by the consumer means the possibility of obtaining some cost advantages. These advantages emerge as a result of saving money both at the stage of heating system construction using PU-insulated pipes and in the process of their operation.

The operating costs reduction is achieved through the reduction of inefficient losses of heat, major repairs, lower pipeline accident rate and other circumstances suggesting that these technologies can be recommended for implementation.

The effectiveness of this measure is proved by the successful implementation of many regional programmes in the area of energy and heat saving; in this context, the long-term experience of the regions in using this technology can be successfully integrated into the heat saving programmes also for other constituents of the Russian Federation.

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