Trubaev, Pavel A.; Tarasyuk, Pavel N.

Article

Evaluation of energy-saving projects for generation of heat and heat supply by prime cost forecasting method

International Journal of Energy Economics and Policy

Provided in Cooperation with:
International Journal of Energy Economics and Policy (IJEEP)

Reference: Trubaev, Pavel A./Tarasyuk, Pavel N. (2017). Evaluation of energy-saving projects for generation of heat and heat supply by prime cost forecasting method. In: International Journal of Energy Economics and Policy 7 (5), S. 201 - 208.

International Journal of Energy Economics and Policy

ISSN: 2146-4553

available at http: www.econjournals.com

International Journal of Energy Economics and Policy, 2017, 7(5), 201-208.

Evaluation of Energy-saving Projects for Generation of Heat and Heat Supply by Prime Cost Forecasting Method

Pavel A. Trubaev[1]*, Pavel N. Tarasyuk[2]

[1]Department of Power Engineering of Heat Technologies, Belgorod State Technological University named after V.G. Shukhov, Belgorod, Russia, [2]Department of Power Engineering of Heat Technologies, Belgorod State Technological University named after V.G. Shukhov, Belgorod, Russia. *Email: trubaev@gmail.com

ABSTRACT

After analyzing the current condition, it has been concluded that there are difficulties using the standard methods of economic analysis for evaluating the efficiency of energy-saving projects in systems of heat generation and heat supply for own requirements or in enterprises of monopolistic position. It is suggested to use the forecasting of the prime cost value of heat produced in prices of the accounting period instead of the discounting method, i.e., without bringing the cash flows to the united basis. The advantages of the method suggested consist in the possibility of differentiating the change of cost for each cost item, varying the change of items in different periods, forecasting the long-term development of enterprises and regions with the use of real volumes of funds for the future years, forecasting the possible risks by changing the coefficients employed and evaluating their influence on efficiency of the project. The suggested approach allows developing forecast scenarios for heat supply enterprise upgrade projects while also evaluating the effect of investments on the performances of the enterprise, selecting the required amount of investments, crediting parameters that ensure keeping growth of heat energy tariffs to the minimum. The method has been tested out for municipal heat supply organizations.

Keywords: Energy Saving, Investments, Prime Cost, Heat Supply, Long-term Projects, Forecasting
JEL Classifications: L98, Q49

1. INTRODUCTION

The use of standard economic methods of investment projects evaluation causes difficulties in problems of producing energy for own requirements because the energy generated is not a ware and there is no profit from selling it. So for such problems the conventional "intrinsic value" is introduced. Similarly, it turns out difficult to evaluate investments for centralized heat supply systems uniting the heat sources and water heating networks. As a rule, such systems occupy the monopolistic position in the market due to technical limitations, with the cost of energy in them determined by the prime cost of its generation and delivery and being subject to state regulation (Estache and Kaufmann, 2011).

As a result, all costs for construction, upgrade and energy efficiency enhancing of heat supply systems are shifted on the cost of the end product or on the heat energy users. So the problem of evaluating the economic efficiency for energy-saving measures (Sorrell, 2004) and heat supply systems upgrade (Jedral, 2012) makes it essential to develop methods that would account for the reduction of financial load for the main production (DeCanio and Watkins, 1998) or users.

The objective of the work is to develop methods of economic evaluation of energy-saving measures applied in upgrade of heat-generating equipment and heat supply enterprises. For this, the method of evaluation of investment projects of energy-saving measures introduction for a prolonged accounting period with varied degree of cash flows discounting. Instead of the discounting method, it is suggested to use forecasting the prime cost value of heat generated in prices of the accounting period, i.e. without bringing the cash flows to the united basis. The suggested method was tested out for five municipal heat supply organizations.

2. REVIEW OF THE EXISTING METHODS OF EVALUATION OF INVESTMENTS INTO ENERGY-SAVING MEASURES

The methods of evaluation of investments into energy-saving measures are analyzed in a number of works (Popp et al., 2009).

In conditions of the planned economy, the reduced costs minimizing method was widely used for comparative evaluation of different options of measures (Boguslavskij, 1990):

$P = K + T\,O$,

Where P is the reduced costs in rubles; K is the capital investments, rubles; O is the current annual expenses for the operation of equipment or buildings, rubles; T is the standard time of the equipment or buildings operation, years.

The best (optimum) variant corresponds to the minimum value of P variable. e.g. in the works of Boguslavskij (2006), the cost of heat insulation is used as the K value, variable O stands for expenses for heating the building, and variable T – for the heat insulation lifetime. The K and O variables are written down as functions of resistance to heat transfer R of the fencing structure elements, and the value of R corresponding to the minimum P is found by differentiating.

The disadvantages of the reduced costs minimizing method when using the evaluation of energy-saving measures are as follows (Gagarin, 2009):

- Gradual reduction of the effect of measures due to the equipment wear-out and loss of properties of the materials with the course of time;
- Lack of methods for precisely determining parameter T which is generally adopted based on some common assumptions.

The economic efficiency criteria currently used for justification of energy-saving projects are discussed in many works (Newell et al., 1999). For evaluation, the simple criteria – without time factor borne in mind – and the integral (discounted) criteria can be used.

The simple criteria are applied for low-cost or fast-payback measures (Tabunshhikov and Shilkin, 2005), among them the following:

- Annual increment of the net profit (production costs saving) which characterizes the value of profit remaining at the enterprise's disposal (it is only used in the business sphere);
- Non-discounted (simple) payback period which characterizes the term of return of investments (this is a multi-purpose criterion to be used both for business and for budget-funded organizations and individuals).

The integral coefficients calculated using discounting are employed for cost-intensive or slow-payback measures (Kurbatov and Naumenko, 2014). Discounting (adjustment) is the accounting of cost change by adjusting the costs and results to one period (Gilligham et al., 2009). As the integral indicators, the following are used in the business sphere (i.e. for profit-making organizations and enterprises) (Figure 1).

- Net present value (NPV);
- Return on investments;
- Internal rate of return (IRR);
- Discounted payback period (DPP).

For energy saving projects, one of the most demonstrative economic criteria is the project payback period (Boguslavskij et al., 1990). In the work by (Tabunshhikov and Shilkin, 2005), the following ways of calculation of payback period for energy-saving measures at the expense of receipts from energy resources saving are given:

1. Non-discounted investments payback period T_0, years:
$T_0 = \Delta K/\Delta A$;

2. With the incoming receipts discounted, T_r, years:
$T_r = -\ln[1-rT_0]/\ln(1+r)$;

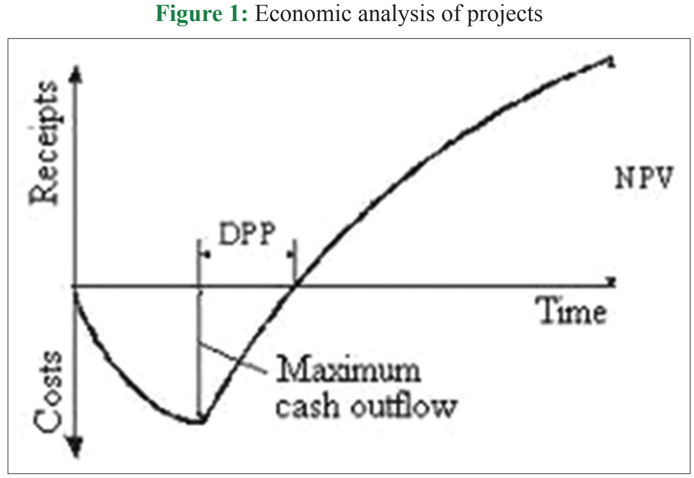
3. With increment (capitalization) of the incoming receipts T_{incr}:
$T_{incr} = \ln[1+rT_0]/\ln(1+r)$.

Here ΔK is the investments into energy-saving measures, rubles; ΔA is the additional annual income at the expense of energy resources saving, rubles/year; r is the calculated norm of discount, as a rule it is adopted at the value of the Central bank refinancing rate, inflation level or the interest rate for credit funds.

In the work by Kovalev (2013), it is pointed out that evaluation of efficiency based on DPP is highly likely to lead to unjustified capital investments due to the high income discount rate in Russia. The author suggests to evaluate the efficiency based on the discounted rate of return throughout the entire operation life of the equipment (materials).

As a rule, the operation life is 50 years and more for the new buildings and 15 years at least for power generation and engineering equipment (Radhakrishnan et al., 2007). In these cases, the objectivity of use of the integral indicators depends on the correctly determined discount rate *r* for the given period of time (Tabunshhikov and Shilkin, 2005). Alongside with that, the value of the effect due to reduced consumption of energy carriers

Figure 1: Economic analysis of projects



is influenced by their cost (Tabunshhikov et al., 2004). Thus, an essential disadvantage of the cash flows discounting method is the complexity of forecasting the cash flow from investments (Buzova et al., 2003) as well as the problem of discount rate selection (Kosov et al., 2000). For calculation of saving with energy saving, the discounting method also has a great disadvantage because it ignores the increased saving due to the growth of cost of energy resources, the change of conditions for environmental charges accrual and subsidies obtained (Kornilova and Trubaev, 2016), the change of heat consumption market structure due to a larger share of renewable power generation (Schleich and Gruber, 2008), and higher energy efficiency with end users (Kushhev and Dronova, 2008).

Figure 2 shows the dynamics of growth of energy carriers cost, wages and inflation (the indicators that form cash flows from investments into energy-saving measures) in Russia over the recent 10 years. The curve shows the non-linearity of change of the indicators as well as disproportion in changes of some of them. Thus, applying one calculation discount rate for all indicators will lead to an incorrect evaluation of cash flows and, therefore, to mistakes in investments efficiency evaluation for the long-term accounting period.

Source: According to the data of Russian Federal State Statistics Service at www.gks.ru

Some works suggest investments evaluation methods designed for energy-saving projects. For instance, in the work by Vasiljev and Kolesova (2011) an optimization model is suggested that includes some economic and environmental requirements.

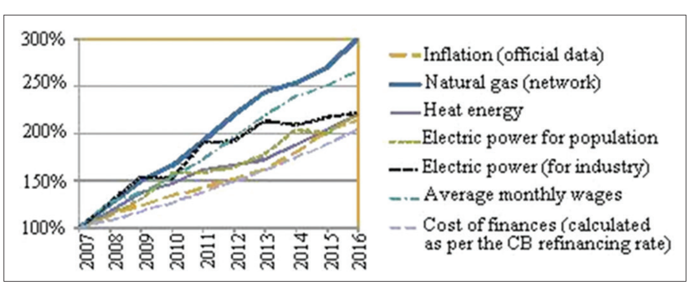
The payback criterion for nonrecurring costs of heat insulation of buildings is suggested in the work by (Gagarin, 2009):

$$-\Delta K/\Delta k < 0.024.HPDD.C_h/r = \omega,$$

Where ΔK is the amount of credit in a bank per building area unit, rubles/m^2; $\Delta k = k_1 - k_0$ is the difference between heat transfer coefficients of basic fence k_1 and calculated option k_0, W/(m^2.K); HPDD – heating period degree-day, °C.day; C_h is the cost of heat energy; and r is the fixed annual credit rate.

The left part of the inequality is determined by the heat insulating properties and cost of the structure and shows the costs for reduction of its heat transfer coefficient. The right part, ω, is determined by climatic and economic characteristics and sets the limit value for costs payback. The lack of price discounting is the disadvantage of the method (Gagarin, 2009).

Figure 2: Dynamics of growth of energy carriers cost and economic indicators



Source: According to the data of Russian Federal State Statistics Service at www.gks.ru

It can be concluded that the methods of evaluation of the efficiency of investments into energy-saving measures, particularly as for the mid- and long-term ones, need adjustment (Kovalev, 2013).

Special attention should be paid to feasibility study of projects for enterprises the activity of which is subject to state regulation. As an example of state regulation for monopolistic energy supply systems (Shirrime and Trubaev, 2016), a number of regulatory acts of the Government of Russia can be cited. According to Resolution of the RF Government dated 22.10.2012 No. 1075 "on price formation in the sphere of heat supply," two methods can be applied for determining the tariffs regulated:

- The method of economically justified expenses (costs);
- The method of set tariffs indexation.

In the first method, the calculated regulation period amounts to not more than 1 year and it makes 3-5 years in the second one. Both methods are based on the use of the necessary gross earnings as determined for the relevant regulated activity and the calculated value of productive supply of the relevant type of products (services) for the calculated regulation period. Investments in the gross earnings can be accounted for by two methods:

- As expenses for capital investments (investments) in the calculated regulation period; this is determined on the basis of investment programs approved;
- As funds for loan servicing (money funds formed at the expense of obtaining credits, loans, issue and selling of bonds and spend on creation, reconstruction and upgrade of production objects).

The expenses associated with loan servicing cannot exceed the value equal to the Russian Federation Central bank refinancing rate increased by 4% points.

Thus, the investments into upgrade of production objects for the period of obtaining of the necessary funds will lead to the increase of the required gross earnings and, therefore, to higher tariffs for heat energy. However, with regard to this the upgrade results in costs saving and prime cost reduction. So with contracting loans a part of loan servicing funds will be made up by the saving obtained (Doroshenko et al., 2013). Although this will require the increase of gross earnings for the credit interest value, it will lead to maintaining the tariff and perhaps even to reducing it for the loan capital repayment time.

3. RESEARCH METHODS

This section suggests the method of forecasting the prime cost of generated heat. Due to the standard methods of economic analysis of the efficiency of investments into energy-saving measures being inapplicable for resource-supplying organizations which generate and sell products in the regulated activities, it is suggested in the paper to evaluate the upgrade according to the forecast value of the generated heat prime cost. With regard to this, the investment

Table 1: Structure of prime cost of heat

No.	Constituent name	Calculation formula
1	Energy resources	
1.1.	Fuel	$C_{fi}=Q_i \cdot g_{fi} \cdot P_{fi}=Q_i \cdot g_{fi} P_{f0} (k_f)^i$
1.2.	Electric power for production needs	$C_{ei}=Q_i \cdot g_{ei} \cdot P_{ei}=Q_i \cdot g_{ei} \cdot P_{e0} \cdot (k_e)^i$
1.3.	Water	$C_{wi}=C_{w0} (Q_i/Q_0) \cdot (k_w)^i$
2.	Direct costs	
2.1.	Direct labor costs (for the main production personnel) with the UST	$C_{OPi}=C_{OP0} (n_{OPi}/n_{OP0}) \cdot (k_{aw})^i$
2.2.	Maintenance and repair, materials for operation	$C_{ri}=C_{r0} (a_i/a_{maxi})/(a_0/a_{ma\times 0}) \cdot (k_{inf})^i$
2.3.	Depreciation	Determined according to the depreciation charging method used in the heat supply organization
2.4.	Production character services (testing of instruments, third-party organizations, labor safety)	$C_{si}=C_{s0} \cdot (k_{inf})^i$
3.	General administrative expenses	
3.1	Labor costs for the general administrative personnel with the UST	$C_{GPi}=C_{GP0} \cdot (k_{aw})^i$
3.2	Dispatching service (wages of personnel, transportation expenses)	$C_{d\,i}=C'_{d0} \cdot (k_{inf})^i$
4.	Loan servicing	
4.1.	Loan repayment, thousand rubles	$C_{loan\,i} = \sum_{j=1}^{J} \begin{cases} \frac{Z_j}{2n_j}, \text{ if } i=s_j \text{ or } i=(s_j+n_j); \\ \frac{Z_j}{n_j}, \text{ if } s_j<i<(s_j+n_j) \end{cases}$
4.2.	Interests on loan, thousand rubles	$C_{inti} = (\sum_{j=1}^{J} (Z_j, \text{ if } j^3 sj) - \sum_{r=0}^{i} C_{loan\,i})r$

project has to provide for the limitation of the prime cost (tariffs) growth, its value not exceeding the inflation value.

The main constituents of cash flows – cost of energy resources, wages, as well as inflation – feature quite different growth rates (Figure 2), which does not allow averaging them in a united discounting rate because this will lead to a completely unpredictable end result.

So for the analysis, instead of the discounting method, a more painstaking technique was used which provides for adjustment of all factors influencing the cash flows of projects under comparison. The analysis was performed in prices of the accounting period, i.e. without bringing the cash flows to the united basis. This method has the following advantages:

- The change (growth) of cost of each cost item can be differentiated, including the cost of energy resources of various types;
- The coefficients of change of costs and the cost can be varied for different time spans (years);
- Costs and effect from several measures taken in different time spans with different conditions of funds raising can be accounted for;
- The change in effect of measures with the course of time due to equipment wear-out and loss of properties of the materials can be accounted for;
- The development of enterprises and regions can be forecast on a long-term basis using the relevant volumes of money funds for the future years and the change of the volume of energy resources generated or consumed.

It is suggested to carry out the upgrade at the expense of loan funds. The crediting method selected is the one with differentiated annual payments and regular debt repayment, the interests being accrued on the actual remainder.

The following prime cost items of heat listed in Table 1 are suggested for determining the gross earnings.

Legend:

i – accounting year (the base year i =0 corresponds to the beginning of the project);

C_{fi}, C_{ei} – costs for fuel and electric power in the accounting year;

C_{wi}, C_{w0} – costs for water in the accounting and base year;

C_{OPi} C_{OP0} – direct labor costs in the accounting and base year;

C_{ri}, C_{r0} – costs for repair in the accounting and base year;

C_{si}, C_{s0} – costs for production character services in the accounting and base year;

C_{GPi}, C_{GP0} – labor costs for the general administrative personnel in the accounting and base year;

C_{di}, C'_{d0} – costs for dispatching service in the accounting year and ones brought to the base year prices;

C_{loani}, C_{inti} – costs for repayment of the main part of the loan and interests on it;

k_f, k_e, k_w – coefficients of annual increase of the cost of fuel, electric power, water; k_{inf} – inflation coefficient; k_{aw} – annual wages indexation coefficient;

Q_i, Q_0 – the quantity of heat sent out in the accounting and base year;

g_{fi}, g_{ei} – net fuel and electric power consumption for heat generation;

P_{fi}, P_{f0}, P_{ei}, P_{e0} – cost of fuel and electric power in the accounting and base year;

n_{OPi}, n_{OP0} – quantity of the main production personnel in the accounting and base year;

a_0, a_i – average operation age of boilers in the base and accounting year;

a_{max0}, a_{maxi} – average service life of boilers in the base and accounting year;

J – quantity of years during which the upgrade takes place;

Z_j, s_j – the amount of investment costs (loan amount) in the j^{th} year

and the number of the year;
n_j – the quantity of years for which loan is taken on;
r – loan interest rate.

4. RESULTS AND DISCUSSION

An example of forecast of the prime cost of heat in the municipal unitary enterprise "Heat networks" of Ivnyanskiy area of Belgorod region is considered below. It was expected to perform the upgrade of boiler stations in the area in three stages (Table 2). The first stage of the program involves the large central boiler station which has the shortest payback term of the measures taken. The second stage deals with inefficient boiler stations with the average payback term of the measures, and the third one implies reconstruction of inefficient boiler stations featuring the long-term payback and dispatching.

The upgrade was expected to be conducted using loan funds. The term of loan is 5 years, annual interest of the loan is 11.5%.

As the base year indicators, the prime cost and financial data of the enterprise for 2019 were used. The following indicators were used for forecasting the prime cost of heat: k_f = 1.15; k_e = 1.13; k_w = 1.13; k_{inf} = 1.07; k_{aw} = 1.10; Q_0 = 2531244 Gcal; n_{OP0} = 92; a_0 = 16; a_{max0} = 16; J = 3.

Table 2: Upgrade stages

Year	Quantity of boiler stations to be upgraded	Power of the boiler stations, MW	Cost, $	
			In 2010 prices	With inflation
2018	1	6.03	176,617	176,617
2019	9	5.76	551,300	587,133
2020	8	3.16	481,817	541,350
Total	18	14.95	1209,734	1305,100

Calculation of the prime cost of heat before and after the upgrade is given in Annex P 2.5. The changed structure of the prime cost after the upgrade allows forecasting the reduction of the prime cost of heat energy by 33% after completion of all reconstruction measures. The results of the forecast calculation in the accounting period prices are given in Table 3.

In Figure 3, the tariff obtained as a result of the investment project is compared to the one obtained without any investments. As it is evident from the Figure 3, the upgrade leads to the increased tariff in the short term – due to having to service and repay the loan funds, but already in 5 years the resulting tariff is clearly lower.

In Table 4, the costs for loan funds servicing and saving as a result are compared. As it can be seen from the data given, saving due to the upgrade will exceed the credit servicing cost only in the 5th year of fulfillment of the program. However, with the upgrade program partially subsidized from the budget funds, the saving

Figure 3: Comparison of the heat energy tariff under the investment project and without the upgrade, given 10% annual forecast growth

Table 3: Forecast of the prime cost of heat energy in prices of the accounting year, $/GJ

Indicators	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
1. Energy resources											
1.1. Fuel	2.95	3.68	3.92	4.10	4.55	5.05	5.61	6.22	6.91	7.67	8.51
1.2. Electric power for production needs	0.68	0.77	0.69	0.56	0.62	0.68	0.75	0.83	0.92	1.02	1.12
1.3. Water	0.11	0.14	0.16	0.18	0.20	0.22	0.24	0.27	0.29	0.32	0.36
2. Direct costs											
2.1. Direct labor costs (for the main production personnel) with the UST	1.73	1.90	1.85	1.34	0.64	0.71	0.78	0.86	0.94	1.04	1.14
2.2.1. Repair	0.18	0.20	0.17	0.13	0.14	0.15	0.16	0.16	0.17	0.18	0.19
2.2.2. Materials for operation	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24
2.3. Depreciation	0.01	-	-	-	-	-	-	-	-	-	-
2.4. Production character services (testing of instruments. third-party organizations, labor safety)	0.26	0.28	0.30	0.31	0.33	0.34	0.36	0.38	0.40	0.42	0.44
3. General administrative expenses											
3.1. Labor costs with the UST	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3.2. Dispatching service	-	-	-	0.42	0.89	0.93	0.98	1.02	1.08	1.13	1.19
3.3. Other	0.99	1.06	1.12	1.17	1.23	1.29	1.36	1.42	1.50	1.57	1.65
4. Loan servicing											
4.1. Loan repayment, thousand rubles	-	0.17	0.89	1.95	2.46	2.46	2.30	1.58	0.51	0.00	0.00
4.2. Interests on loan, thousand rubles	-	0.17	0.71	1.07	0.79	0.50	0.24	0.06	0.00	0.00	0.00
Prime cost total	7.07	8.52	9.96	11.40	12.02	12.53	12.96	13.01	12.93	13.57	14.83

Table 4: Evaluation of funds for the loan raised in stages and the economic effect of the measures taken, $

Year	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	Total
Loan amount as of 2018, with inflation	176,617	-	-	-	-	-	-	-	-	-	176,617
Loan repayment	17,667	35,317	35,317	35,317	35,317	17,667	-	-	-	-	176,617
Interests	18,283	14,217	10,150	6100	2033	-	-	-	-	-	50,783
Loan amount as of 2019, with inflation	-	587,133									587,133
Loan repayment	-	58,717	117,433	117,433	117,433	117,433	58,717	-	-	-	587,133
Interests	-	60,767	47,267	33,767	20,250	6750	0	-	-	-	168,800
Loan amount as of 2020, with inflation	-	-	541,350								541,350
Loan repayment	-	-	54,133	108,267	108,267	108,267	108,267	54,133	-	-	541,350
Interests	-	-	56,033	43,583	31,133	18,683	6233	-	-	-	155,633
Repayment of funds, total	35,950	169,017	320,333	344,450	314,433	268,783	173,217	54,133	-	-	1,680,333
Effect from the measures taken (with inflation forecast, growth of energy carrier prices and wages growth forecast)	22,633	92,983	184,217	245,783	275,350	308,200	344,650	385,083	429,950	479,683	2,768,533

will make up the costs for loan funds servicing completely.

The investment projects for the five heat supply enterprises were evaluated similarly. For each one, its own upgrade program was developed with various implementation terms in order to achieve the maximum effect. Different values and structures of reduction of the prime cost of heat generated (Figure 4) were obtained due to the different conditions of work and different efficiency of the enterprises, individual lists of energy-saving measures to be implemented, and different conditions of loan funds raising.

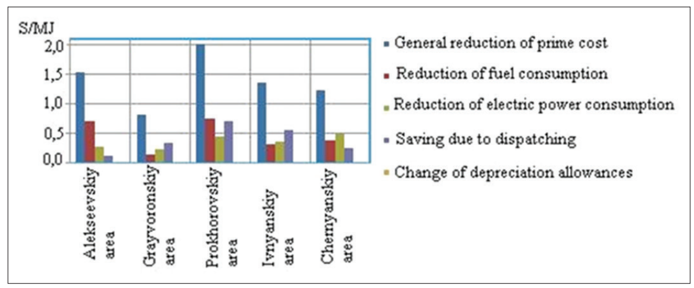
Two indicators were determined for the prime cost: The one without the investment constituent (without the loan repayment installments value) and the full one (including the loan funds servicing costs). Comparing the prime cost (Figure 5) in prices of the base year 2018 allows evaluating the potential efficiency of the upgrade. Comparing the prime cost of heat in prices of the accounting year allows evaluating the actual saving against the work of the enterprise without the upgrade.

As it is evident from the data obtained, the prime cost of heat will grow even after the upgrade, yet its growth rates will be considerably lower than in the previous conditions. Once the project is completed, the average prime cost of heat energy will make the following percentage of the prime cost forecast without the upgrade:

Alekseevskiy area	75%
Grayvoronskiy area	87%
Prokhorovskiy area	71%
Ivnyanskiy area	81%
Chernyanskiy area	79%

Therefore, the approach suggested allows developing the forecast scenario for the heat supply enterprise upgrade projects while

Figure 4: Prime cost reduction structure due to the upgrade



at the same time evaluating the influence of investments on the enterprise performances, selection of the investment volumes required, and crediting parameters ensuring the minimum growth of heat energy tariffs.

The technique also allows evaluating the risks of project implementation by changing the coefficients used (Shhenjatskaja et al., 2016).

The risks that may arise during the performance of the program can have the following causes.

1. Reduction of the load connected after installation of metering devices. The situation development forecast has shown that in this case the prime cost will grow but the relative effect of the upgrade – i.e. the difference between the prime cost in the project and without that – will remain unchanged.
2. Unpredictable growth of cost of energy carriers. In this case, the prime cost will grow both with and without the upgrade, but the relative indicators of the investment project will improve.
3. Credit rate increase and the crediting term reduction. In this case, the indicators will be worse in the 1st years of the program implementation. Once the remaining credit sum on which the interests are paid is reduced, the project will come back to the basic option indicators.

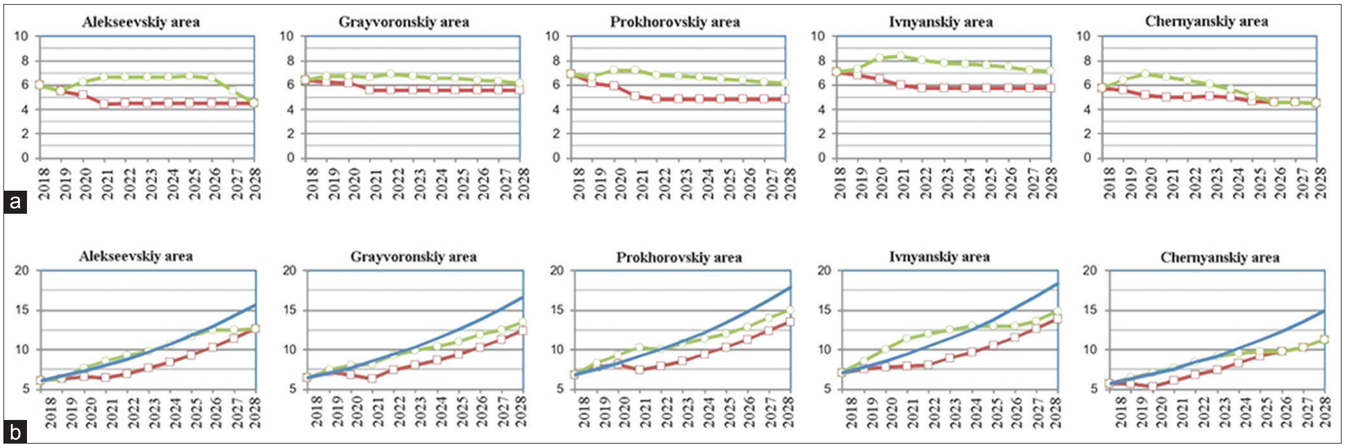


Figure 5: Heat prime cost forecast, $/GJ. (a) in 2018 prices. (b) In the accounting year prices
– without the investment constituent (loan repayment installments value not included); – the complete one, including the loan funds servicing costs; – without the upgrade

Thus, according to the analysis, the approach suggested allows forecasting the possible risks and evaluating their influence on the efficiency of the project.

5. CONCLUSION

For evaluating the efficiency of energy-saving projects in systems of heat generation and heat supply for own requirements or in enterprises of monopolistic position (those engaged in regulated activities), the standard methods of economic analysis cannot be applied because the cost of heat is determined on the basis of actually incurred costs and the upgrade costs are included into the tariffs as the investment constituent. Hence the efficiency of the upgrade of heat supply organizations has to ensure the absence of further financial loads for the consumers with its technical constituent.

The main constituents of cash flows – cost of energy resources, wages, as well as inflation – feature quite different growth rates, which does not allow averaging them in a united discounting rate because this will lead to a completely unpredictable end result. So it is suggested to use for the analysis the forecasting of the prime cost value of heat produced in prices of the accounting period instead of the discounting method, i.e. without bringing the cash flows to the united basis.

The suggested approach allows developing forecast scenarios for heat supply enterprise upgrade projects while also evaluating the effect of investments on the performances of the enterprise, selecting the required amount of investments, crediting parameters that ensure keeping growth of heat energy tariffs to the minimum not exceeding the inflation value.

The advantages of the method suggested are as follows:
- The possibility of differentiating the change of cost for each cost item, various energy resources included;
- The possibility of varying the cost change coefficients in different time spans (years);
- The possibility of forecasting the long-term development of enterprises and regions with the use of real volumes of funds for the future years;
- Forecasting the possible risks by changing the coefficients employed and evaluating their influence on efficiency of the project.

6. ACKNOWLEDGMENTS

The article was prepared within development program of the Flagship Regional University on the basis of Belgorod State Technological University named after V.G. Shukhov.

REFERENCES

Boguslavskij, L.D. (1990), Economy of Warmth in Residential Buildings. Moscow: Strojizdat.

Boguslavskij, L.D. (2006), Decrease in Power Consumption During the Work of Heating and Ventilation Systems. Moscow: Strojizdat.

Boguslavskij, L.D., Livchak, V.I., Titov, V.P. (1990), Energy Saving in Heat Supply, Ventilation and Air Conditioning Systems. Moscow: Strojizdat.

Buzova, I.A., Mahovika, G.A., Terehova, V.V. (2003), Commercial Assessment of Investments. Saint Petersburg: Piter.

DeCanio, S.J., Watkins, W. (1998), Investment in energy efficiency: Do the characteristics of firms matter? Review of Economics and Statistics, 80, 95-107.

Doroshenko, Y.A., Somina, I.V., Rijova, A.S. (2013), Practices of introduction into modern conditions. Middle East Journal of Scientific Research, 9, 1337-1342.

Estache, A., Kaufmann, M. (2011), Theory and evidence on the economics of energy efficiency. Lessons for the Belgian building sector. Reflets Perspectives, 23, 133-148.

Gagarin, V.G. (2009), Methods of economic analysis for the increase in the level of heat-shielding of the protecting structures of buildings. AVOK, 1, 10-16.

Gilligham, K., Newell, R.G., Palmer K. (2009), Energy Efficiency Economics and Policy. Working Paper No. 15031. Cambridge: NBER. Available from: http://www.nber.org/papers/w15031.pdf.

Jedral, W. (2012), Comparison between the costs of utilization of energy efficiency reserves in thermal power plants and heating plants and the costs of construction of new energy sources. Journal of Power

Technologies, 92(3), 174-182.

Kornilova, N.V., Trubaev, P.A. (2016), Definition of pollutants emissions in the hot-water boiler at burning of the different hard waste. International Research Journal, 10, 123-126.

Kosov, V.V., Livshhic, V.N., Shahnazarov, A.G. (2000), Methodical Recommendations on the Efficiency Evaluation of Investment Projects. Moscow: Economics.

Kovalev, I.N. (2013), Assessment features of cost efficiency of long-term investments in energy saving actions. Energy Saving, 2, 52-58.

Kurbatov, V.L., Naumenko, S.M. (2014), Globalization of energy saving problems and identifying of the ways of solving them in investment-building complex. Life Science Journal, 11(8), 553-557.

Kushhev, L.A., Dronova, G.L. (2008), Ways to decrease energy costs in housing and communal services. Bulletin of BSTU named after V.G. Shukhov, 2, 24-25.

Newell, R., Jaffe, A., Stavins, R. (1999), The induced innovation hypothesis and energy-saving technological change. Quarterly Journal of Economics, 114, 941-975.

Popp, D., Newell, R., Jaffe, A. (2009), Energy, the environment, and technological change. In: Hall, B., Rosenberg, N., editors. Handbook of Economics of Technical Change. Oxford: North-Holland. p873-937.

Radhakrishnan, V.R., Ramasamy, M., Zabiri, H., Do Thanh, V., Tahir, N.M., Hamdi, M.R., Mukhtar, H., Ramli, N.M. (2007), Heat exchanger fouling model and preventive maintenance scheduling tool. Applied Thermal Engineering, 27, 2791-2802.

Schleich, J., Gruber, E. (2008), Beyond case studies: Barriers to energy efficiency in commerce and the services sector. Energy Economics, 30, 449-464.

Shhenjatskaja, M.A., Avilova, I.P., Naumov, A.E. (2016), Assessment of financial and economic risks of the investment and construction project within deficit of basic data. Bulletin of BSTU named after V.G. Shukhov, 1, 185-189.

Shirrime, K.J., Trubaev, P.A. (2016), Evaluation features of energy efficiency indicators for municipalities' subdivisions. International Research Journal, 10, 123-126.

Sorrell, S. (2004), The Economics of Energy Efficiency: Barriers to Cost-Effective Investment. Camberley: Edward Elgar.

Tabunshhikov, J.A., Shilkin, N.V. (2005), Assessment of cost efficiency investments into energy saving actions. AVOK, 7, 10-21.

Tabunshhikov, J.A., Kovalev, I.N., Gegueva, E.O. (2004), Basic principles of cost efficiency assessment for the means of energy saving of buildings. AVOK, 5, 36-47.

Vasiljev, G.P., Kolesova, M.V. (2011), Economically and ecologically reasonable level of heat-shielding of buildings. Herald of MSBU, 8, 293-302.