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Methods of Evaluating the Efficiency of Energy Saving Projects with Taking risks Into Account

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ABSTRACT

The relevance of the problem studied in the article is caused by the fact that now the process of reforming the housing and utilities sector in the Republic of Tatarstan continues. Its purpose is to increase the quality of service for public and to protect their legitimate rights and interests. That is why it is one of the aspects of social and economic policy. All mentioned above determines the necessity of implementing energy saving projects and evaluating their efficiency. The purpose of the article is quantitative evaluation of the efficiency of investment project in the field of energy saving with estimation of the risk of its implementation. The leading method to study this problem is the quantitative approach of evaluating the project risks, based on the analysis of sensitivity and project risks scenarios which are calculated by using discount method of its efficiency. Such methods provide the accuracy of the calculations. In the article we made evaluation of economic efficiency in housing and utility sector. We also detected the most critical factors for implementing the projects in the field of energy saving and made quantitative assessment of their influence. We also made the reasonable conclusions about the necessity of risk evaluation by using methods of sensitivity and scenario evaluation. Results of calculating the project efficiency in the field of energy saving and the results of analyzing sensitivity of the factors that influence the project can be useful when implementing similar project.

KEYWORDS
Energy saving, evaluation of project efficiency, sensitivity analysis, evaluating the risks

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Introduction

Relevance of the Problem

Issues of upgrading material and technical resources of housing and utilities are relevant due to the continuing reforming in this sector. In order to

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make this sector normally function and for its further development it is necessary to search for investments and to implement real energy saving project that allow to provide the increase in the efficiency of its functioning. Implementation of the projects will increase the quality of service for housing and utilities consumers. Taking into account the complexity and the variety of the projects in this field, the evaluation of risks of their implementation becomes relevant.

Explore Importance of the Problem

Reforming in housing and utilities sector tremendously raised the questions of upgrading material abd technical resources in this field. Right now new Civil, Housing and Urban Planning codes of Russian Federat5ion are accepted. The sector now uses a new system of paying for housing and utilities. A new Energy Saving law was accepted (The law of 2009) along with other regulations implementation of which requires constant rethinking about the content of reforms.

Balanced work of this socially oriented sector with long term perspective assumes implementing innovations in upgrading material and technical resources in this sector, particularly connected with implementing resources saving technologies that include energy and heat saving technologies. At that the innovations perform as an iformational exchange product as it is virtually impossible to develop a fundemental introduction with the use of a single copmany's resourses (Vaks, 2015). The relevance of these issues is also confirmed by accepting the law about innovation activity in the Republic of Tatarstan (The law of Russian Federation, 2010) and also by Energy and Resource Efficiency

Program which are now in action in the republic. Particularly these are the issues related to implementing resource saving technologies that include energy and heat saving technologies.

Studies un the issues of energy and heat saving by industrial and housing and utilities companies are disclosed in the articles by V.I. Sharapov & P.V. Rotov (2009), A.I. Kolesnikov (2008). Economy aspects of justification of organizing energy saving activities and projects are reflected in articles by A.A. Andrizhievsky & V.I. Volodin (2008), D.G. Rodionov (1999), G.M. Kvon (2009, 2011a, 2011b, 2015), F.F. Khamidullin & G.M. Kvon (2012), G.M. Kvon & R.R. Akhmetzyanova (2011).

In this respect based on the results of monitoring energy resources consumption in Kazan City, (Kvon, 2011a) the authors developed a version of a program that contains the activities for increasing the efficiency of energy use (Kvon, 2011b).

The essence of the investment project

A set of basic technical activities for energy saving and increasing energy efficiency in housing and utilities in Kazan City can be conventionally divided into following directions: generating energy, heating systems, residential buildings. Every direction in its turn includes a number of activities that provide resources saving in housing and utilities field.

We suggest that we discuss energy generation direction where it is possible to implement such a project as “Cogeneration high-efficiency mini-CHPP”

We will give a brief description of the project. Cogeneration (2016) power plant represents highly effective use of prime energy source (natural gas) in order to get two kinds of energy – heat energy and electric energy. The main advantage of cogeneration plant in comparison with usual thermal power plant is the fact that energy is transformed with high efficiency. Using such a plant allows decreasing the necessity to purchase energy. So using cogeneration plants in large cities allows to effectively contribute to energy supply market without the need to modernize networks. At the same time the quality of heat and electric energy is increased. Cogeneration (2016) unikt produces electric and heat energy with the ratio 1:1, 5.

Based on the results of monitoring heat and electric energy consumption made by the authors before (Kvon, 2011b), an increase of consumption was detected which can be explained neither by the increase of houses nor by the increase of population that was noticed in a number of districts in Kazan within several years. It can be explained by old communication lines in residential sector. Heat boiler stations that supply heat and power supply lines work on the edge of maximum power and overload. It results in great losses that guarantee overconsumption which is paid by payers. That is why in order to solve the problem we suggest that heat boiler stations with high level of overload should be upgraded up to mini-CHPP.

Materials and Methods

Task of the study

During the study the following tasks were fulfilled by the authors:

— Project selection;

— Explanation of project efficiency calculation methods;

— Selection and explanation of benchmark data for calculating the project;

— Calculation of the project cost-effectiveness;

— Project risks quantitative assessment;

— Analyzing project implementation results.

Theoretical and empirical methods of study

During the work different methods were used:

— statistic methods;

— discount methods of project evaluation;

— quantitative methods of risks assessment: analysis of sensitivity and scenarios;

— methods of analysis and synthesis.

Evaluation criteria

Economic evaluation of effectiveness of implementing investment projects in the field of energy sawing is made with the use of a number of criteria based on discount concept. According to best practices of project efficiency evaluation and Investment efficiency evaluation guide (Berens & Havranek, 1995) dynamic indicators of efficiency are used which include:

– NPV – Net Present Value of the project;

– IRR – Internal Rate of Return;

– PI – Productivity Index of the project;

– DPP – Discount Payback Period.

Evaluations of investment project risks, according to Best Practices (Best Practices, 2010), should be made taking into account risk and uncertainty. The uncertainty means the information about the conditions of project implementation which is not complete or not accurate and the risk means the occurrence of such conditions that will result in negative consequences for all or for some participants of the project.

Project sensitivity analysis is the method to increase the reliability of calculation results. It does not evaluate the risk of the whole project but detects its most critical factors. The purpose of sensitivity analysis is to evaluate how much project efficiency would change if one of the initial parameter changes. The limits of factor variations are defined by project developers. UNIDO methods recommend changing parameters within the limits from -20% to +20% (Berens & Havranek, 1995).

The algorithm of sensitivity analysis is consists of the following steps:

- the most probable basic parameters that influence the indicators of investment project efficiency are defined;

- project efficiency indicators are calculated using the selected values of initial parameters;

- investment efficiency indicators are selected and project sensitivity evaluation is made in relation to them.

- investment project indicators are calculated in a sequence when the main factors change;

- the calculations are summarized in a table, project sensitivity is evaluated on every factor (parameter) in order to define the factors that are the most critical for the project.

As we already said in order to make such an analysis it is necessary to have basic calculation of investment project efficiency. According to the recommendation for developing scenarios, which can deteriorate the project indicators the following can be used as the parameters:

- investment costs;

- volume of production (manufacturing products, servicing);

- cost of production and sale (in a whole the main attention should be paid to changing prices for raw and other materials on the market);

- interest on the credit in case of loan raising;

- other parameters.

So it is recommended to check practicability of the project and evaluate its efficiency depending on the changes of above mentioned parameters within certain limits.

Stages of the study

The study of the problem was made in three stages:

On the first stage we made theoretical analysis of the existing methodology approaches from scientific literature, thesis researches on the problem and the theory and methods of evaluating the efficiency of investment projects in the field of energy saving, the problem, the purpose and the methods of study were defined; the plan of study was made.

On the second stage based on existing energy saving project analysis we selected the project for calculation the project, the methods of energy saving investment project evaluation were developed, factors that influence the project implementation results were detected, the search for data necessary for calculations was made.

On the third stage economic efficiency of the project which is the basis for evaluating risks was evaluated; criteria for the development of three project scenarios were selected, the calculation results were received, practical conclusions were made, the results were summarized and classified.

Results

Calculation of the project basic version

Implementation of any investment projects including the project in the field of energy saving is connected with the need of substantial investment for a relatively long period. It is clear that according to what we said above the effect of investment solution of constructing mini-CHPP will be evident only after some (maybe quite long) period of time. That increases the uncertainty (Samysheva & Meshchanov, 2013) of perspectives and risks of the project.

As we said before when describing calculation methods for evaluating risks it is necessary to have basic version of project efficiency calculation.

The results of calculation of basic version of this project efficiency are given in Table 1. According to the methodology the calculation are made for a certain calculation period. In this project it is considered to be 10 years long.

Table 1. Results of the calculation of basic version of feasibility study of mini-CHPP project

Indicators	Unit of measure	The values of indicators
Initial data		
1. Operating income (annual revenue)	$$	867405,09
2. Annual operating costs	$$	379733,33
3. Profit	$$	487 671,76
4. Net income (profit)	$$	390137,41
5. Net cash flow	$$	526 614,37
Project performance indicators		
1. NPV	$$	1300809
2. PI	shares of units	1,69
3. IRR	%	37
4. DPP	year	3,3

Project sensitivity analysis

Let us evaluate the risk using method of analyzing sensitivity of the project “Implementing cogeneration highly effective mini-PHPP in the city of Kazan”.

In order to analyze sensitivity of this investment project the factors "investments" and "volume of production due to implementing mini-PHPP in Kazan" were selected as varying parameters.

The changes of project indicators depending on the amount of investments are given in Table 2.

Table 2. Changing project efficiency indicators depending on the change of "investment" factor

Project performance indicators	Change of investments (in % of the planned level)				
	-20%	-10%	0%	10%	20%
Investments, $$.	1688076,6	1688076,6	1875640,7	2063204,7	2250768,8
NPV, $$.	1635745,3	1468277,4	1300809,5	1133341,6	965873,6
PI, shares of units	2,1	1,9	1,69	1,5	1,4
IRR, %	53%	44%	37%	31%	27%
DPP, year.	2,1	2,7	3,3	3,8	4,4

According to the calculations when "investment" factor changes, to be more precise, if the amount of investments increases by 20% the efficiency indicators of this project deteriorate. If we have the planned level of investment and NPV indicator is equal to 1300809,5 USD, then if investments increase by 20% NPV will decrease to 965873,6 USD.

Payback period of the investment project will increase up to more than one year what will negatively affect its marketability; that means that the higher is the amount of investment the worse effect it has on the project. That means that increase of investments in this project will negatively affect its efficiency.

Another factor that affects the efficiency indicators is the volume of production (operating income) of mini-CHPP. This factor may change under the influence of demand for the products of mini-CHPP. The change of efficiency indicators depending on changing this parameter is given in Table 3.

Table 3. Changing project efficiency indicators depending on the change of "operating income" factor

Project performance indicators	Change in operating income (in % of the planned level)				
	-20%	-10%	0%	10%	20%
Operating income, $$	693924,08	780664,58	867405,09	954145,60	1040886,11
NPV, $$.	705711,75	1003260,62	1300809,48	1598358,35	1895907,21
PI, shares of units	1,4	1,5	1,7	1,9	2,0
IRR, %	25%	31%	37%	43%	49%
DPP, year.	4,7	3,9	3,3	2,7	2,3

As we can see in Table 3, when the "income" factor decreases by 20% the investment project efficiency indicators also decrease. The NPV indicator is more influenced by this factor change than the internal rate of return (IRR), which did not substantially changed by the “income” factor.

Calculating Elasticity Coefficient

In order to define the degree of influence of these parameters let us calculate elasticity coefficient of the project. Calculation results on the parameter “investments” are given in Table 4.

Table 4. Calculations of elasticity coefficient under the influence of “investments” factor

Project performance indicators	The coefficient of elasticity changing investment (in% of the planned level)			
	-20%	-10%	10%	20%
NPV, $$.	1,29	1,29	1,29	1,29
PI, shares of units	1,17	1,04	0,85	0,78
IRR, %	2,21	1,88	1,46	1,32
DPP, year.	1,72	1,72	1,72	1,72

The elasticity coefficient value above 1 indicates substantial influence of the factor on efficiency indicators. When the factor changes by 1%, the resulting indicators change by more than 1%. As we can see from Table 4 the influence of “investment” parameter is substantial when the amount of investments decreases by 20%. For the project the increase of investment by 20% will lead to a more substantial increase of efficiency indicators than decreasing this parameter.

Let us calculate project elasticity under the influence of “income” parameter (Table 5).

Table 5. Calculation of project elasticity coefficient under the influence of “income” factor

Project performance indicators	the elasticity coefficient of the change in operating income (in% of the planned level)			
	-20%	-10%	10%	20%
NPV, $$.	2,29	2,29	2,29	2,29
PI, shares of units	0,94	0,94	0,94	0,94
IRR, %	1,58	1,61	1,69	1,74
DPP, year.	2,15	1,92	1,57	1,44

As we can see from Table 5 NPV indicator is the most influenced indicator by this parameter. Decreasing the income affects resulting indicators more substantially for the whole project than its increase.

Net Present Value (NPV) was selected as the key factor when plotting the ray path plot of investment project sensitivity to the change of initial parameters (fig. 1).

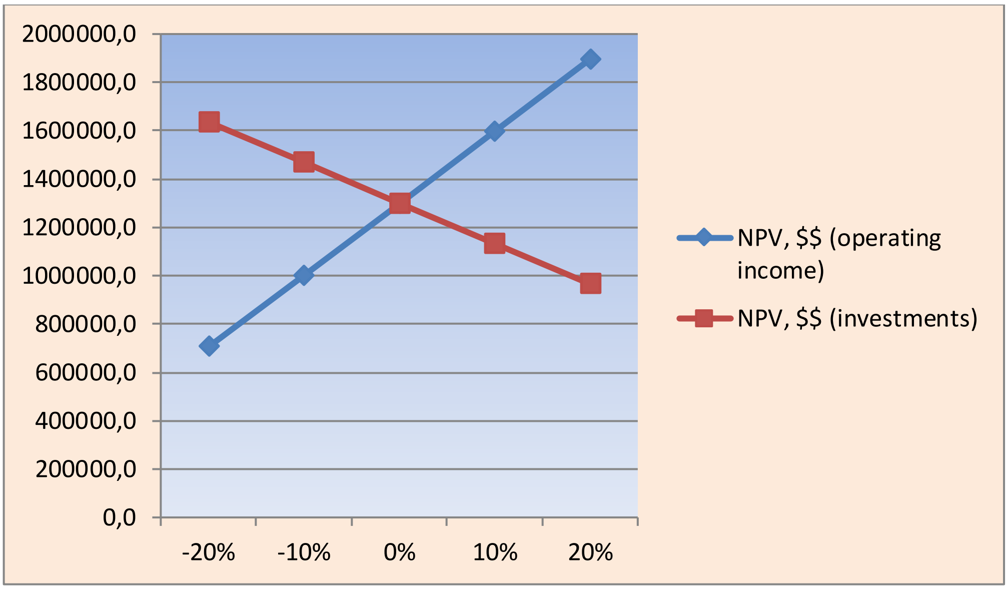

Figure 1. Investment project sensitivity to changing the factors “investments” and “income”

The more is the incline of the line that characterizes the parameter change influence on NPV to Y axis the,ore sensitive is the investment project.

In this case the project is more sensitive to the change of “income” factor. That means that when implementing the project special attention must be paid to the factors that can lead to decrease of this factor.

Analyzing scenarios of project implementation development

Sensitivity analysis lets us define the influence of each factor but it has some disadvantages since it does not allow taking into account all the circumstances influencing the project as a whole. When analyzing we should be aware that selected factors may be non-independent and their change may happen simultaneously.

Scenario analysis allows improving sensitivity analysis and correcting its drawbacks. It is less time consuming method of formal description of uncertainty. Scenario algorithm is the following:

- developing possible scenarios of investment project implementation;
- defining net present value in every scenario;
- defining the probability of implementing each scenario;
- calculating expected net present value taking probability into account.

According to scenario analysis method it is necessary to develop the options if investment project implementation and to define by expertise the probability for each option. So we consider three scenarios of development: pessimistic, probable, optimistic. The appropriate values of factors selected are detected in each scenario, after that project efficiency indicators are calculated and expected NPV and risk values are defined (Table 6).

Table 6. Project efficiency depending on the scenario

Scenario	The probability of realization, %	Factor	Value (% of the plan)	NPV, $$	IRR, %	PI	DPP, year
Pessimistic	30	Investments	120	370775,9	18%	1,2	6,1
		Operating income	80				
Optimistic	10	Investments	80	2230843,0	72%	2,5	1,4
		Operating income	120				
Most possible	60	Investments	100	1300809,5	37%	1,7	3,3
		Operating income	100				

The study showed that if we take a pessimistic scenario of project development the company will have to expect the income lower by 20% when the investments increase by 20%. On the other hand, optimistic scenario is possible: income and investment amount will make 120% and 80% from the planned respectively. The chance that the second scenario will develop is 60%, for the pessimistic scenario the chance of development is 30%, and for optimistic scenario it is 10%. The expected value of NPV is determined the following way: $370775{,}9 \times 0{,}3 + 2230843 \times 0{,}1 + 1300809{,}5 \times 0{,}6 = 1114802{,}77$ USD

So in comparison with sensitivity analysis results we received a more accurate complex evaluation of the efficiency. It is necessary to pay attention to the fact, that NPV value of the investment project will be 370775,9 USD in pessimistic scenario and 2230843,0 USD in optimistic scenario. NPV value does not pass the point "0" and does not reach negative values what means low uncertainty of the investment project.

Discussions

When implementing energy saving project it is important to take into account specific features of housing and utilities as part of service sector, main stages of housing and utilities reforms that are carried out in the country and the reason that retard its development.

The priority directions to upgrade housing and utilities are: controlled accountancy of all types of energy consumption, automation of heat consumption, decreasing heat losses are described by V.I. Sharapov & P.V. Rotov (2009) in his articles. Perspective direction of heat energy sources upgrade is using gas-turbine and CCGT units, which allow substantial increase of CHPP efficiency factor or arranging combined production of electric power and heat energy in heat boiler stations by transforming them into small CHPP using minimum of investments. It is reasonable to further develop and implement the complex of science-an-technological solutions that will be able to put heat supply systems into operation according to modern requirements.

Methods of complex analysis of effective energy use when it is produced, transferred and consumed offered by A.A. Andrizhievskiy (2008) include the analysis of energy efficiency of energy use and economic efficiency of energy saving activities.

In D.G. Rodionov's (1999) article the essence, the necessity and main directions of changes in housing and utilities under the conditions of market formation are explained taking into account foreign experience. The study of business basis for housing and utilities as the complex part of service sector is given.

The further development of issues regarding improving system of managing housing and utilities in order to develop organizational basis for reforming housing and utilities is made in articles by A.M. Saralidze (2002) and E.V. Chekalina (2002).

Main directions of energy saving in regional economy are presented in the article by A.V. Gavrilenko. A.V. Kirsanov (2011), where the authors presented activities of upgrading housing and utilities sector functioning. They involve gradual implementation of market principles of economy management.

An important issue when explaining investment project implementation is calculating their economic evaluation of their efficiency taking risks into account. Explanation of using methods of project efficiency evaluation and evaluating the risks of their implementation are based on using domestic and foreign best practices, presented in Best Practices in Evaluation of Investment Project Efficiency (2010), and also in Investment Efficiency Evaluation Guide (Berens & Havranek, 1995). These arguments are the basis on which we can explain the use of methods of project evaluation.

Economic aspects of implementing innovative investment projects in the field of energy saving in housing and utilities sector are reflected in an article by G.M. Kvon (2011a), where specific features of housing and utilities, the features of evaluating the projects in this field are reflected. Also there presented an energy saving program made on the basis of a number of energy saving projects. Also evaluating risks of energy saving projects and taking them into account are relevant when analyzing and evaluating projects. Methodology aspects of risk evaluation are presented in an article by F.F Khamidullin & G.M. Kvon (2012) on the basis of which the authors made further development of methods of analyzing sensitivity and project scenarios and corrections of the data calculated earlier.

Results received by the authors of this article confirm the feasibility of implementing the presented project in the field of energy saving taking into account its necessary checking for stability the tools of which are sensitivity and scenario analysis.

Conclusion

So the project under survey involves implementation of cogeneration highly effective mini-CHPP that will allow saving resources in the field of housing and utilities. Evaluating economic efficiency of the project confirms the possibility of its implementation since evaluation criteria satisfy the necessary requirements for making positive investment decision.

In the article quantitative risk evaluation of this project was made. The existence of such a risk is connected with impossibility to exactly forecast the future. Here we can detect its main feature: risk is relevant only in relation to the future and is tightly connected with prognosis and planning and consequently with making investment decision as a whole.

In the article risk evaluation was made on two factors: investments and income, the value of which substantially affects the effectiveness of the project. Taking into account the detected risks will allow explaining to investors the necessity of making management decision based on understanding the project development forecast.

Disclosure statement

No potential conflict of interest was reported by the authors.

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