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INVESTMENT IN ENERGY SAVING ACTIONS OF INDUSTRIAL ENTERPRISES

The paper analyses the process of investing in energy saving actions of industrial enterprises. The main stages of the investment research project implementation have been reasoned, its general methodology has been developed. The example of calculating the optimum program of financing the energy saving actions has been provided for multiple alternative projects.

Keywords: *investments; energy saving; industrial enterprises; alternative projects.*

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ІНВЕСТУВАННЯ ЗАХОДІВ ЕНЕРГОЗБЕРЕЖЕННЯ ПРОМИСЛОВИХ ПІДПРИЄМСТВ

У статті розглянуто процес інвестування заходів енергозбереження промислових підприємств. Обґрунтовано основні етапи проведення інвестиційного дослідження та сформовано його загальну методологію. Наведено приклад розрахунку оптимальної програми фінансування енергозберігаючих заходів при багатоваріантних альтернативних проектах.

Ключові слова: *інвестиції, енергозбереження, промислові підприємства, альтернативні проекти.*

Форм. 3. Рис. 2. Табл. 1. Літ. 11.

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ИНВЕСТИРОВАНИЕ МЕРОПРИЯТИЙ ЭНЕРГОСБЕРЕЖЕНИЯ ПРОМЫШЛЕННЫХ ПРЕДПРИЯТИЙ

В статье рассмотрен процесс инвестирования мероприятий энергосбережения промышленных предприятий. Обоснованы основные этапы проведения инвестиционного исследования и сформировано его общую методологию. Приведен пример расчета оптимальной программы финансирования энергосберегающих мероприятий при многовариантных альтернативных проектах.

Ключевые слова: *инвестиции, энергосбережение, промышленные предприятия, альтернативные проекты.*

Problem setting. The reduction of energy resources consumption, the improvement of environmental situation, the decrease in fixed costs of the enterprise and, as a result, the increase in profitability can be achieved by the introduction of energy saving actions. The necessary researches for the identification of the key directions in energy saving are carried out by energy auditing companies, and possible directions of investment are determined by the economic and mathematical modelling being accomplished during economic control. The specific feature of energy saving actions is that they cannot be divided into parts, i.e. they cannot be financed partially. Making a choice of the sources for financing, the enterprises have to choose between the use of only their own internal assets or both internal and external funds. Also there is a variation in quality of the equipment and materials. As the result, there is a large number of possible options of financial investments, and the optimum choice is a difficult task.

Latest research and publications analysis. The analysis of publications enables to find out only the solution of the tasks directed at investing in general production

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processes not taking into account the peculiarities of energy saving projects. The problem of investment is usually solved by Bellman's method (1962), the shortest multistep search method. O.A. Shumeyko (2012) offered the dynamic model of optimum distribution of investments in equipment replacement. A.O. Nedosekin (2003) used the theory of fuzzy logic for the solution of financial management problems. A.S. Tsesliv and K.A. Rakusevich (2011) suggested the model for calculating the enterprise profitability in equipment replacement. The researches of T.M. Borovskaya (2009) are directed at the solution of problems related to optimum distribution of funds by means of accomplishing a variation task by the method of the maximum principle. V.F. Savchenko and O.O. Romashkin (2009), T. Ben (2007) investigated the task of the analysis of alternative projects and the issue of optimum placement of investments. The problem of investments distribution between the energy saving projects at industrial enterprises is still unresolved.

The research objective is the development of a method for analyzing the efficiency of investments into alternative multiple energy saving projects. To achieve the above ojective we need to address the following:

1. To consider peculiarities of energy saving actions in terms of investment.
2. To develop the general mechanism of a choice of optimum ways of financial investment in alternative projects.
3. To give an example of calculations by the offered mechanism instruments.

Key research findings. The investment in energy saving is profitable for enterprises because simultaneously with the growth of profitability many other problems might be solved, such as environmental problems, the improvement of internal microclimate, the reduction of social tensions etc. The majority of actions cannot be invested partially, therefore in terms of the economy financial investments are to be considered as those which cannot be divided. Taking into consideration different periods of projects implementation the assessment of their annual profit is not an objective indicator, therefore it is offered to use the net specified value of this investment project as a financial result of realization of an energy saving action. And it is offered to count NPV on the entire period of realization of action taking into account the liquidating value. For financing these actions an enterprise can use both internal and external funds in various combinations.

The main sources for financing are as follows:

- internal financial resources (profit, depreciation costs, funds from investors and others);
- borrowed funds (bonds or credits);
- investments from local budgets or the state budget;
- foreign investments from individuals, legal entities or banks and financial institutions;
- financial leasing;
- combination of the above sources.

After the assessment of financial stability of an enterprise and calculation of the ratio of its internal and external funds it is possible to make a conclusion about the optimal capital structure. The main lever of the variation is the discounting coefficient which can have different meanings depending on the ratio of internal and external funds. For further calculations the discounting coefficient is in the fixed state depending on the decision made as to the financing sources. Its value varies from the minimum – usually from a deposit rate by which it would be possible to increase the funds while putting them on a bank account, to the maximum – for example, a credit rate of the short-term credit. After a choice of value of a discounting coefficient we calculate the aggregate net present value of NPV action which depends on initial capital investments, annual profit and the liquidating value (1). The main condition of modelling is obtaining the maximum total NPV value at unsurpassed sums of funds, which are allocated for these actions.

$$NPV = -i_j + \sum_{j=1}^{N} \frac{dV_j}{(1+r_j)^j} + \frac{C}{(1+r_{N+1})}, \quad (1)$$

where C – the liquidating value, UAH; N – the last year of project consideration x_j; i_j – the investments into the project x_j; dV_j – the annual income from this action, UAH.

For solving the issue of a choice of the optimal financing directions it is necessary to set certain conditions of modelling:

$$\begin{gathered} f(z) = \max_{x_1,\ldots,x_n} \left\{ \sum_{j=1}^{n} NPV_j(x_j) \right\}; \\ \sum_{j=1}^{n} i_j(x_j) \le z; \\ x_j - whole,\ j = 1,\ldots,n; \\ N_j = [1\ldots100]; \\ Q = const, \end{gathered} \quad (2)$$

where z is the maximum amount for investment in energy saving, UAH; z_j – the quantity of funds allocated for the action j; x_j – the project number, chosen for the action j; NPV_j – the net present value of the project x_j; $f(z)$– the maximum aggregate net present value which will be received from implementation of the projects x_1, x_2, ... x_n at the set volume of investments z; N_j – the expert indicator of quality, which can vary from 0 to 100.

In our calculations it is assumed that outputs remain constant: $Q = const$.

The method of calculation of the optimum directions of investment is based on the following steps:

1. According to the results of economical inspection a number of energy saving actions is defined which reveals the practical potential for energy efficiency.

2. The assessment of financial stability of an enterprise and its profitability is carried out, the indicators of its financial autonomy and financial risk are defined, the break-even point is calculated, the conclusion on the level of financial stability is drawn by the three-component indicator.

3. The value of financial and operational leverage is calculated. The decrease in operational leverage is in a direct ratio to the profit received from energy saving actions. Therefore, by comparison of actions in terms of production risks decrease the preference is shown to those which have higher net present value. Financial leverage is calculated as the ratio of external funds to internal funds. By this indicator it is possible to define the possibility of raising funds for financing energy saving actions.

4. The optimum value of investment capital is defined further reflected in the calculations of the discounting coefficient of r. For this purpose it is necessary to resolve the following tasks:

- To define the optimal capital structure (depending on the ratio of internal and external funds in the amount of investments);
- To determine the cost of capital.

The average cost of capital is defined as follows:

$$WACC = w_d \times k_d + w_p \times k_p + w_e \times k_e, \quad (3)$$

where w – a part of sources of financing (respectively the value of the sold shares, liabilities and assets of an enterprise); k – the cost of financing sources.

At these calculations it is necessary to take into consideration the value of equity capital which can be estimated by defining profit on reinvestment in the company or into deposit accounts of banks. At a choice of optimum structure of the capital there are 3 major theories of decision-making: traditional theory (Bespalov, 2010) the supporters of which are of the opinion that there is an optimum distribution of capital and its value depends on its structure; Modigliani-Miller's theory (Modigliani and Miller, 1958), which states that under certain conditions the value of capital does not depend on its structure (the ratio of internal and external funds), and the theory of compromise of R. Brealey and S. Myers (1997) which takes into account peculiarities of taxation and expenses of the company for elimination of financial difficulties. Enterprise management, relying on these theoretical principles and results of the financial analysis of the enterprise, chooses the optimal capital structure.

Graphically, the optimal value of coefficient of discounting can be determined by the creation of investment schedule and projects schedules. The point of intersection of these schedules enables to define the optimal value of the discounting coefficient (Makhovnikova and Kantor, 2001) (Figure 1).

5. From the general set of possible actions during the preselection procedure enterprise management makes a certain choice under the following conditions:

$$IRR > r = WACC, \quad (4)$$

where IRR – the internal standard of project profitability.

For this purpose the schedules represented in Figure 1 are also used. The zone of admissible projects is above the investment schedule. It is convenient to use the graphic decision at insignificant number of alternative projects. If their quantity is significant and if each of them has several options of realization (Figure 2), there is a need for software solution of this task by means of the detailed investigation of options.

6. The expert evaluation of quality of equipment or materials to be used in each action is defined. Each expert, assigns his own estimated quality rating. Then for each option the average expert evaluation is estimated and the conclusion on the quality of this action is drawn.

7. For each option of energy saving action the three options of quality are chosen, i.e. satisfactory, good and excellent.

8. For the chosen types of quality for each of the energy saving actions NPV values are calculated. The matrix is formed consisting of capital costs, corresponding to them NPV values at the given value of quality.

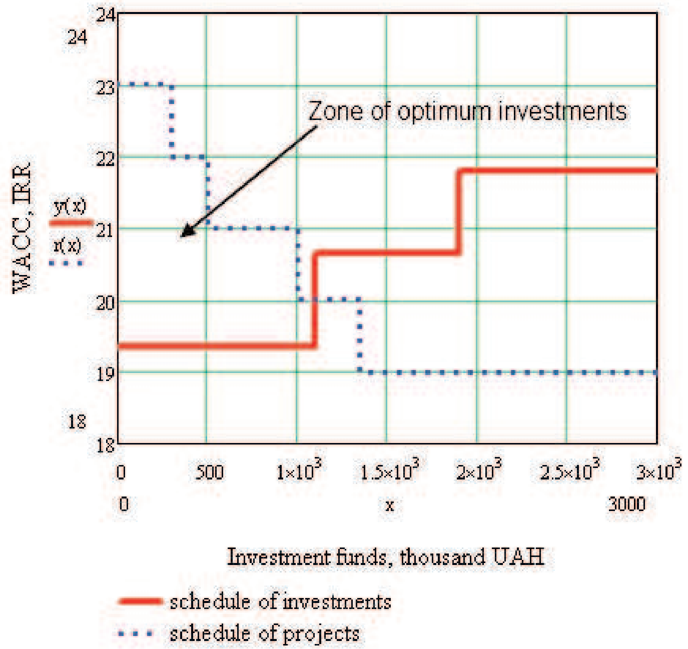

Figure 1. **Determination of optimal discounting coefficient and the zone of admissible projects,** *author's development*

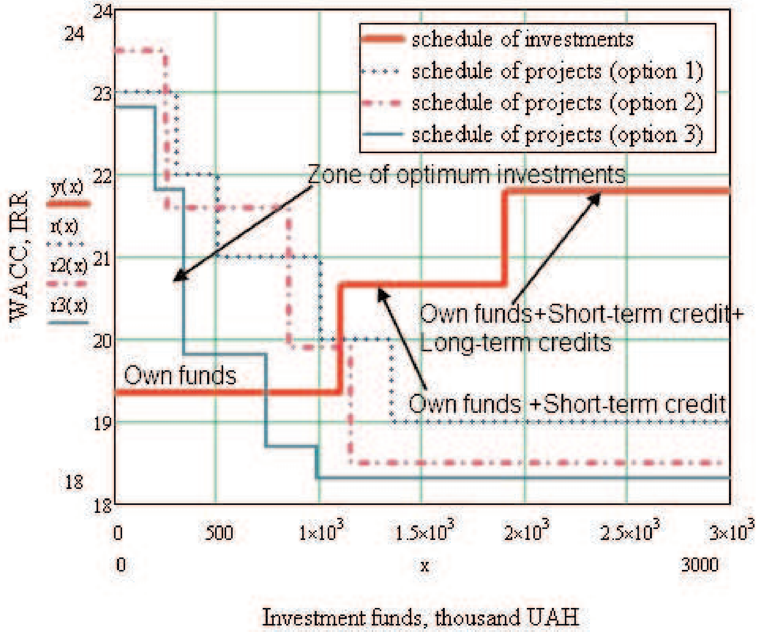

Figure 2. **Determination of optimal discounting coefficient and the zone of admissible projects at a multiple choice of alternative projects,** *author's development*

9. The method of detailed verification of elements of the matrix (Table 1) under initial conditions (2) defines the maximum aggregate net present value of *f(z)* which will be received from the projects implementation x_1, x_2, ... x_n at the given amount of investments *z*. The method of detailed verification is realized by means of the software package SciLab.

Table 1. **Distribution of investments into energy saving actions,** *ths UAH, author's development*

quality	Action #1 10 years			Action #2 15 years			Action #3 15 years			Action #4 8 years			Action #5 12 years		
	I	c	NPV	I	c	NPV	I	c	NPV	I	c	NPV	I	c	NPV
satisfactory	10	5	148	800	15	117	-	-	-	260	40	72	400	100	330
good	15	6	165	1500	20	131	120	8	135	400	55	98	560	120	364
excellent	25	7	209	2400	30	199	200	10	197	-	-	-	670	180	453

Let's review the example of calculation of optimal investment distribution into energy saving actions at a machine-building enterprise. Ten possible actions have been offered for implementation, five of them have been chosen at the preselection by the enterprise management. Each of these actions can be implemented using the equipment of different quality or different materials. After the analysis of financial stability of the enterprise short-term credits and internal funds have been chosen as a source of financing. The discounting coefficient has been calculated as $r = 0.18$. The annual profit of each action is different, as well as the terms of project implementation. The initial conditions for the calculations of each action and terms of its realization are given in Table 1. The maximum amount of investments is 2 mln UAH. Satisfactory quality for action No. 3 and excellent quality for action No. 4 are not considered by the management of the enterprise. All actions need to be realized in any option of quality.

After calculations we receive the solution in the form of 3-1-2-1-3 and the maximum aggregate net present value: $\sum_{j=1}^{n} NPV_j(x_j) = 986000\ UAH.$ The funds spent for carrying out energy saving actions are: 25 +800 +120 +260 +670 = 1875 ths UAH.

Conclusions:

1. There have been considered the peculiarities of energy saving actions in terms of investments. The key specific feature of their financing is that actions cannot be divided and that there are several options of implementation of the same action.

2. A general mechanism of a choice of optimum ways of financial investment in alternative multiple-choice energy saving projects have been developed. The technique is based on the determination of optimal value of the discounting coefficient, on the assessment of financial stability of the enterprise and on the method of detailed verification of options.

3. An example of calculations using the above mechanism technique has been given.

4. In further research it is necessary to pay attention to the assessment of quantitative and qualitative characteristics of energy saving projects in the mechanism of their choice.

References:

Бень Т. До визначення економічної ефективності інвестицій // Економіка України.– 2007.– №4. – С. 12–19.

Беспалов М. Теоретические подходы к формированию и оптимизации финансовой структуры капитала компании // Финансы: планирование, управление, контроль.– 2010.– №3. – С. 24–30.

Брейли Р., Майерс С. Принципы корпоративных финансов. – М.: Олимп-Бизнес, 1997. – 1120 с.

Маховникова Г.А., Кантор В.Е. Инвестиционный процесс на предприятии. – СПб.: Питер, 2001. – 176 с.

Моделювання і оптимізація процесів розвитку виробничих систем з урахуванням використання зовнішніх ресурсів та ефектів освоєння: Монографія / Т.М. Боровська, С.П. Бадьора, В.А. Северілов, П.В. Северілов; За заг. ред. Т.М. Боровської. – Вінниця: ВНТУ, 2009. – 255 с.

Недосекин А.О. Финансовый менеджмент на нечетких множествах: Монография. – М.: Аудит и финансовый анализ, 2003. – 184 с.

Савченко В.Ф., Ромашкін О.О. Аналіз альтернативних проектів та оптимальне розміщення інвестицій // Актуальні проблеми економіки.– 2009.– №4. – С. 179–187.

Цеслів А.С., Ракусевич К.А. Дослідження проблеми підвищення прибутковості підприємства при заміні обладнання // Вісник КНУТД.– 2011.– №1.– С. 143–147.

Шумейко О.А. Динамічна модель оптимального розподілу інвестицій при заміни обладнання // Економіко-математичне моделювання соціально економічних процесів.– 2012.– №17. – С. 255–267.

Bellman, R., Dreyfus, S. (1962). Applied Dynamic Programming. Princeton: Princeton University Press. 364 p.

Modigliani, F., Miller, M.H. (1958).The Cost of Capital, Corporation Finance, and the Theory of Investment. American Economic Review, June: 261–297.

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