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Article

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Energy Saving Projects as Energy Security Factors

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ABSTRACT

National economic development, its effectiveness and competitiveness in domestic and foreign markets are directly determined by the country's economic resilience, which is able to ensure protection of its interests at the international level, promote economic growth and address public needs. One of the most important components of the country's national security is its energy security. In this regard, implementation of energy resource-saving technologies and enhancement of energy efficiency is of prime importance; in particular, solving heat related problems, i.e., heat transfer challenges while reforming and reorganizing Russian regional heat supply system. The main purpose of the paper is to study the issues connected with development and implementation of investment projects in the sphere of heat conservation and efficiency as one of the essential components contributing to energy efficiency programs in cities, regions, country. The survey methodology includes a quantitative method used to assess the effectiveness of an investment project which is based on the concept of discounting, the grouping technique, and tabular and graphical methods of data visualization. The paper presents result of evaluating the effectiveness of an investment project aimed at energy-saving, and energy efficient technologies in the field of heat saving. The projects implemented contribute to improvement and further development of the energy infrastructure of social-and-economic assets in order to improve their energy efficiency. The authors draw conclusions on the projects' effectiveness and urgency. Paper materials are of practical value for professionals involved in the study of investment projects in the field of energy and heat saving in order to ensure energy security of the country.

Keywords: Economy, Economic Security, Energy Security, Energy Efficiency, Heat Saving, Investment Project
JEL Classifications: D24; Q43; M31

1. INTRODUCTION

In the current economic conditions of the ever-changing business environment, the questions of prompt response come to the fore. The Strategy of Russia's Economic Security for the Period to 2030 approved by the Russian President defines the economic challenges, threats and also the goals, priority areas and tasks for state economic security policy. It states that "At the present stage of global development… Significant changes take place in… the political, military and economic spheres." According to the document it is necessary to prevent crisis situations in the raw materials, production, science and technology, financial sectors, strengthen social and political stability, and maintain and increase the population's life quality (The Strategy of Russia's Economic Security for the Period to 2030, 2017).

The strategy identifies the main challenges and threats to Russia's economic security, the energy security of the country being one of its aspects; it indicates the low rate of economic growth due to a number of reasons, one of them is associated with insufficient development of energy infrastructure. The strategy also presents the objectives of state policy to achieve the sustainable economic growth, the "introduction of promising energy-efficient technologies" (The Strategy of Russia's Economic Security for the Period to 2030, 2017). It is important that the strategy presents indicators of the state of economic security, such as the energy intensity of the gross domestic product, as well as the balance of production and consumption of energy resources (per capita).

In fact, energy security is one of the most important components of the national security. Earlier, the Energy Strategy of Russia for the Period up to 2030 (Energy Strategy of Russia for the Period up to 2030, 2009) stressed the importance of the implementation of investment projects in the field of energy saving, in particular heat saving, aimed at the development and renovation of fixed production assets and infrastructure of the energy sector. The Energy Strategy considered the need to address the development of domestic energy markets in connection with 'unsolved problems in reforming and restructuring of heat supply and the creation of local heat markets', as well as the need to "develop urban heating development programs in many regions" (Energy Strategy of Russia for the Period up to 2030, 2009). These goals should be implemented using measures and mechanisms of the state energy policy: Elaboration and implementation of regional energy programs, regional programs of energy saving, maximization of the cost, effective use of local energy resources, development of cost effective decentralized and individual heating systems (Energy Strategy of Russia for the Period up to 2030, 2009).

Scientific and technical policy in the energy sector, according to the Strategy, determines an issue of improving technologies of industrial production of heat pipelines, as well as assembling heat supply networks on their basis.

Despite the fact that a number of regions have successfully implemented energy-saving technologies, it is indicated in the Economic Security Strategy of 2017 (The Strategy of Russia's Economic Security for the Period to 2030, 2017) that the result of the implementation of the previous National Security Strategy (The National Security Strategy of the Russian Federation until 2020, 2009) for the Period up to 2020 (which is no longer valid) should be recognized unsatisfactory. The negative assessment of the document is due to the fact that despite a number of measures taken in this area there is still "high depreciation of fixed assets of heat supply (up to 65-70%), the length of heat networks decreased by 7% (>13.5 thousand km), losses in heat networks increased (from 14 to 20%)" (The National Security Strategy of the Russian Federation until 2020, 2009).

2. LITERATURE REVIEW

Research in this area has been strengthened with promulgation of the law on energy saving and energy efficiency improvements (The Federal Law, 2009), which contains legal, economic and organizational framework to promote energy conservation and energy efficiency.

The significance of energy saving in improving energy efficiency of the regions was discussed in the article by Lapaeva and Dedeev (2014). The author points out that "domestic energy sector is becoming a deterrent to economic development reducing its competitiveness and efficiency of socio-economic development of the country." The author connects the current situation with the low rate of innovative energy saving technologies introduction. The work also states the need to implement pilot projects with state participation.

A comparative analysis of the state programs in the sphere of energy saving is presented in the paper of Aloyan and Oparina (2016). The author shows the main directions of improving energy efficiency and analyzes the reasons why it appeared to be difficult to fulfill the main provisions of the Energy Strategy until 2020 (2009).

The need to introduce energy-saving technologies in the field of heat saving as one of its challenges was indicated by Kvon (2007). The work of this author also provides a method for calculating the effectiveness of projects in the field of resource saving (Kvon, 2015).

Galperina (2011) presents methodological aspects of the analysis and evaluation of project effectiveness in the field of energy saving. The author shows the stages of implementation of energy saving projects in various enterprises.

Yeltyshev & Khoroshev (2014) indicated the necessity to implement a systematic approach to the development and implementation of programs in the field of energy saving and increasing energy efficiency. The author proposes to formalize the process of developing and implementing programs dealing with energy efficiency improvement through introduction of a "unified system approach to the practical implementation of the concept of energy saving using the program-target method which allows to clearly formalize the tasks, mechanisms of their implementation and control" and their documentary support and confirmation.

Features and systems of heat supply are fixed by federal law "About Heat Supply" as one of the constituents in the system of energy saving in Russian Federation (On Heat Energy Supply, 2010). This law practically singled out and issued heat supply as a separate branch of the economy. The law defines the basis to regulate economic relations in this area, defines the features of the designing, development and operation of heat supply systems, responsibilities of public authorities and managers in regulation and control in this area, as well as the rights and responsibilities of consumers.

Financing of energy saving projects is an urgent task in their implementation and depends on the characteristics and peculiarities of the project. In this regard, a good overview of the sources and methods of project financing was presented by Chernov (2014). According to the author, the most reliable and promising option of financing is the use of the enterprise's own funds (which, in our opinion, is quite controversial due to their insufficiency and even scarcity); he also proposed to interact with credit granting institutions in the field of lending and leasing.

3. METHOD OF DATA ANALYSIS

Development of an investment project at the stage of its preliminary assessment requires a number of regulatory compliances related to:

- Assessment methodology;
- Selecting source data and their grouping;
- Evaluation of the economic efficiency of the project, and making an investment decision.

3.1. Project Evaluation Methodology

The essence of methods used to estimate the efficiency in general is based on the assessment of investment profitability (in comparison with the investment costs). Regardless of the type of projects and their features, the principles enshrined in the guidelines for assessing the effectiveness of investment projects are recommended to be used when making calculations of projects (Guidelines, 2010); the main of which, in our opinion, are the principles of positivity, maximum effect and consideration of the time factor (Galushkin, 2017, 2018). Making calculation of a project involves the use of the concept of discounting that allows taking into consideration diversity of results and project's costs, so the indicators of project evaluation are also called discounted.

Thus, the evaluation of the effectiveness of investment projects is based on the methodology of performance evaluation, involving calculation of generally accepted indicators (Behrens & Havranek, 1995). Such indicators are usually associated with:

- Net Present Value (NPV);
- Internal Rate of Return (IRR);
- Profitability Index (PI);
- Pay-Back Period (PP);
- Discounted Pay-Back Period (DPP).

Design-methodological aspects and an algorithm of calculation of these indicators are presented in the works of Sharpe and Alexander (2016), Lipsits & Kosov (2017), in the above-mentioned methodological recommendations (Guidelines, 2010), etc.

The following formulas have been used to analyze general indicators of investment efficiency:

$$NPV = -I_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = 0 \qquad (1)$$

Net Present Value is an indicator characterizing the difference between the total amount of discounted cash flows for the entire period of the investment project and the initial amount of investment costs.

$$NPV = -I_0 + \sum_{t=1}^{n} \frac{CF_t}{(1+IRR)^t} = 0 \qquad (2)$$

Internal Rate of Return (*IRR*) is the minimum value of profitability at which the invested funds will be repaid for the planned period of the project.

$$PI = \frac{PV}{I_0} \qquad (3)$$

Profitability Index (PI) is equal to the current value of cash flow divided by the amount of investment costs.

PP (DPP) is the length of time required to recover the cost of an investment. The payback period of a given investment or project is an important determinant of whether to undertake the position or project. Longer payback periods are typically not desirable for investment positions. When calculating the discounted payback period (DPP), the values of discounted investment costs and discounted net cash flows are used.

The payback period is determined as follows:
If the amount of cash flows is constant in each period of the investment project

$$PP = \frac{I_0}{CF} \qquad (4)$$

If CFs are not equivalent in different time periods, the value of PP is determined by the sum of its integer and fractional parts. The integer value of PP is the addition of CFs for the corresponding periods of time until the resulting amount approaches I_0, but does not exceed it. The fractional part of PP is determined by the formula:

$$d = \frac{\left(I_0 - \left[CF_1 + CF_2 + \ldots + CF_j\right]\right)}{CF_{j+1}} \qquad (5)$$

Symbol explanation:

$$PV = \sum_{t=1}^{n} \frac{CF_t}{(1+r)^t} \qquad (6)$$

PV – the present value of cash flows, is determined by the formula
I0 – the value of the initial investment costs;
CF_t – cash flow from implementation of the investment project in year t;
n – number of years during which the investment project was (or has been) implemented;
r – project discount rate (most often weighted average cost of capital);
Dt – Depreciation expense in year t;
Pt – the value of the net profit from the project in year t.

3.2. Selection of Initial Data and their Grouping

To calculate expenditures for implementation of an energy-saving pilot project it is necessary to search for the necessary information and group the initial data. At the same time, the activities of the enterprise that is implementing an investment project can be conventionally divided into three types: Investment, operational, and financial. Table 1 shows them in connection with the fact that performance indicators are influenced by initial data in investment and operating activities (we will limit to them).

The initial data for the calculation are presented for the period accounted.

3.3. Project Economics Evaluation and Investment Decision-making

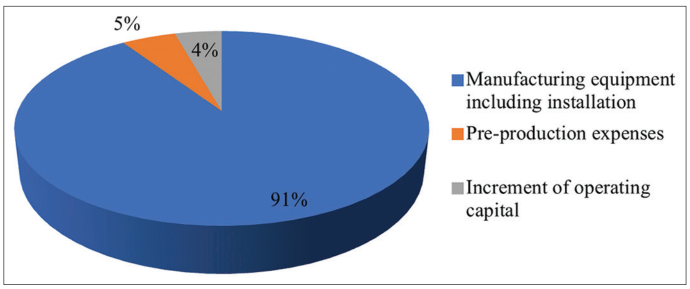
Evaluation of the economic efficiency of the project is carried out considering the above mentioned data/indicators. The following conditions must be met:

1. In terms of NPV
   if NPV > 0, the project is accepted;
   if NPV <0, the project is rejected;
   if alternative projects are presented the project with the highest NPV should be accepted.

Table 1: The list of initial data used in calculation of the investment project

Activities	Data
Investment performance data	Investment costs for the purchase of equipment, land, construction of buildings and facilities, formation of the enterprise infrastructure
	Pre-production costs involved in searching consumers of products, marketing, contracts, etc.
	Incremental working capital costs
Operating performance data	Expected revenue from sales of project products
	Operating expenses (expenses to purchase raw materials, materials, wages and salaries of employees, costs on transportation, electricity, utilities, etc.)
	Depreciation
	Tax deductions
The resulting data	Net profit
	Net cash flow
	Effectiveness indicators

Figure 1: Structure of the project investment expenditures



2. In terms of IRR
   If the internal revenue rate exceeds the price of the invested capital an enterprise should accept the project, when this is not the case it should be rejected.
3. In terms of PI
   The project can be accepted for implementation as long as the value of PI is >1.
   The relationship between the indicators of NPV and PI the following:
   if NPV > 0, PI > 1;
   if NPV <0, PI < 1;
   if NPV = 0, PI = 1.

3.3.1. In terms of PP (DPP)

- Projects with a payback period less than the regulatory period determined by investors (or the economic entity itself) are accepted, and those with a long payback period are rejected;
- In case of several mutually exclusive projects a project with a shorter payback period should be accepted.

4. ESTIMATION RESULTS

The authors' own experience in investigation of the issue concerning evaluation of investment projects in the field of heat saving made it possible to carry out project effectiveness calculation for the process of developing thermal insulation technologies considering the relevance of the issue of heat saving. Earlier, Takhautdinov et al. (1998), Kvon (2007), Postalyuk and Kvon (2014) discussed the results of calculations for organization of similar productions. This paper provides updated data related to calculations for projects in the field of heat saving.

Considering a pilot project and its features we keep in mind that "energy saving" as a term is directly associated with its strategic goal to increase energy efficiency in all sectors, in all settlements and in Russia as a whole. The challenge is to find and select the scope and measures to ensure this increase (Energy Strategy of Russia for the Period up to 2030, 2009). It is necessary to introduce "smart" technologies to contribute to economic feasibility and durability of products. The category of innovative products being introduced for implementation of the heat saving program includes pre-insulated pipes with polyurethane foam (PUF). Due to innovativeness and advantages of heat-insulated pipes, PUF retains heat in the network, it is possible to reduce significantly energy consumption compared to the traditional pipeline. Heat loss is only 2%, while in conventional pipes this figure reaches 20%. In addition, PUF is resistant to extreme temperatures and can be used even in areas of permafrost and abnormal heat.

Depending on the territory of pipeline construction the products are available in three types: For warm, cold and moderate climate territories. They differ in thickness of the insulating layer and price. The products are resistant to the damaging effects of aggressive environment and high humidity. The laying of polyurethane-foam pipes is simple, often there is no need in open-trenches and wells, which significantly reduces the cost of installation cost by 1.2 times and accelerates the object commissioning 2 or 3 times as fast. The facts that they are easier in maintenance and their availability are able to reduce operating costs by 8-10 times. Repair costs of heat transport system decreased by almost 3 times as much. In addition, the polyurethane-foam pipes are very durable. Their adopted service life is not <30 years. The study of pipes in operation process in Western countries for decades shows that their lifespan is >50 years. The calculation of indicators for assessing the economic efficiency of the innovation project under consideration confirms its feasibility.

When calculating the project, the following conditions were accepted:

1. Step-by-step capacity expansion of the project for the production of thermal insulation products. In this project, it is planned to reach full design capacity only in the 4th year of production. The above said is due to the gradual increase in production volumes, also associated with the fact that the company needs time to gain a a solid market position. In this regard, the following quantity of output of pipes and taps

Table 2: Calculation of investment project performance figures

Years	Cash flow from investing activities, $	Cash flow from operating activities, $	Real cash money, $	Cumulative total, $	Discounted cash flow, $	Cumulative total, $
2019	−632775	112194	−520582	−520582	−433818	−433818
2020		211434	211434	−309148	146829	−286989
2021		394210	394210	85062	228131	−58858
2022		613224	613224	698286	295729	236871
2023		613224	613224	1311510	246441	483312
Total		1944285	1311510		483312	

Table 3: Results of the project cost effectiveness analysis

Performance measurement	Values
Net present value (NPV), $3	483311.9
Internal rate of return (IRR), %	61%
Profitability index (PI)	1.76
Pay-Back period, year	2.78
Discounted Pay-Back period, year	3.26

for them (data on taps are presented in brackets) is planned arranged by the year of the calculation period:

1st - 25 km (250)
2nd -35 km (350)
3rd-50 km (500)
4th-65 km (650)
5th-65 km (650)

2. When calculating the project, the inflationary increase in prices for raw materials was not taken into account. The authors are of the opinion that the results and costs of the project have the same tendency to change. In addition, taking inflation into account often improves the results of performance indicators, which can lead to inflated expectations.
3. The plant construction provides for the use of existing assets and facilities. We consider it appropriate to take this fact into account in view of the fact that there is a sufficiently large number of idle premises in any region. The use of this sort of buildings and facilities and assets will significantly reduce the initial cost of the project in terms of the amount of investment costs. In this regard, the cost of investment is mainly associated with the expenditures on the technological line for production of pipes (and taps). The structure of investment outlay is shown in Figure 1.

Taking into account the above assumptions, we have assessed the economic efficiency of the project for 5 year period. Table 2 presents the results of the project effectiveness.
The calculation used/accepted the project discount rate r = 20%. Project cost effectiveness analysis results are presented in Table 3.

The analysis of the results of the project cost effectiveness has confirmed the feasibility of investments in organization of production according to the technology proposed. Project indicators meet the necessary criteria for making a positive investment decision.

5. CONCLUSION

Economic security being considered an important high-quality assessment of the country's economic system establishes its ability to maintain the usual requirements of people to their life, stable endowment with resources for economic stability of the nation, as well as promote people's interests.

Currently, ensuring the economic security of the country is one of the most important issues, and the solution of it ensures independence and stability of the country's economic conditions. The problem of ensuring the country's economic security is closely interrelated with the issue of harmonization of various sectors of the economy; this will ensure the growth of production, especially in the energy sector. The economy now needs to reduce the energy intensity of the country's GDP, i.e., increase energy efficiency. In connection with the above, this sector desperately needs projects aimed at introduction of promising energy-efficient technologies. As it was mentioned earlier, the importance of implementing such energy/heat saving projects aimed at the development and renewal of fixed assets is emphasized in the energy strategy of Russia developed for the period up to 2030. The calculation of the investment project resulting in production of highly efficient heat-saving products proved the feasibility of investment resources committed. The paper has presented calculations of the performance effectiveness that meet the necessary requirements for strategic decision making on investing in a certain new manufacturing technology.

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