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Evaluation of an innovative project of saving energy in housing and communal services

Abstract

The article discusses the questions of theory and methodology of cost effectiveness analysis of an innovative project on energy efficiency in housing and communal services. The paper analyzes the cost effectiveness of an innovative project for the organization of production and commercialization thermally insulated pipes that provide energy saving in housing and communal services in Russia and in one of its region − Tatarstan.

Keywords: energy saving, heat saving, energy efficiency, innovative project, investment support, housing and communal services, economic efficiency.
JEL Classification: Q41.

Introduction

Methodology and results. A systematic approach and a synergistic method of estimation of an innovative project on production and marketing of thermally insulated pipes that provide economic effectiveness of energy saving in housing and communal services have been applied to achieve this goal. These methods made it possible to determine the consistent results rating of the innovative project, which is available in the process of self-organization of innovation cooperation of business, government and society in this sphere. A practical model of the innovative project on the organization of production and application thermal insulated was made with the use of a SWOT-analysis and an economic experiment. The introduction of these methods helped to identify and calculate project indicators, as well as indices for the assessment of economic efficiency of the project on production and marketing of thermally insulated pipes that provide economic effectiveness of energy saving in housing and communal services, received by means of experiment: the net present value of the project (net present value) (NPV); internal rate of return (yield) (IRR); profitability index (PI); payback period (simple − PP and discounted − DPP). Resulting from the calculation the analyzed indicators were respectively: NPV, US $ − 975395, 8; IRR − 69%; PI − 1,91; payback period, years − 2.46.

The analysis data speak in favor of correctness and productivity of innovative managerial decision on the organization of production and marketing of thermal insulated pipes to provide energy efficiency in housing and communal areas in Russia and its regions.

Originality. The originality of the study lies in the fact that, first, it validates a rationale for the positive innovative management in LLC "Teplopipe" on development, organization of production and marketing of thermal insulated pipes in housing and communal services in Tatarstan; secondly, it provides a feasibility study of organization of production of thermal insulated pipes with planned volumes for Tatarstan; thirdly, it demonstrates risk factors of the innovative project and methods to reduce them; fourthly, it defines survival capability variables of LLC "Teplopipe" in the sphere of production, commercialization and application of thermal pipes in the conditions of a potential crisis.

1. Problem statement

The global economic crisis has made energy saving one of the major challenges of the 21st century. Energy for heating one square meter of housing in Russia now is consumed 6-8 times more than in the developed world.

The standard of living depends on how this problem is solved. Russia has not only all necessary and significant natural resources and intellectual capacity to solve its energy problems, but is virtually the resource base for European and Asian countries exporting oil, petroleum products and natural gas in volumes that are strategically important for the importing countries. However, with a large amount of fuel and energy resources, the strategy of Russia should not include energy wastage, since in the open-market economy an energy-efficient economy is the most important factor in the competitiveness of Russian goods and services. Therefore, it is hardly possible to achieve sustainable growth in the gross domestic product (GDP) without changing radically the attitude towards energy and resource saving, without reducing the energy-output ratio. Energy conservation should be a strategic goal and method of ensuring country's energy security, as well as an economizing way when using raw hydrocarbon deposits.

In Russia a priority administrative-legal act in the field of energy conservation is the Federal Act of the Russian Federation dated November 23, 2009 No. 261 – "On energy conservation and raising of

energy efficiency and on amendments to certain legislative acts of the Russian Federation", according to which energy efficiency is the implementation of organizational, legal, technical, technological, economic and other measures aimed at reducing the volume of used energy resources maintaining at the same time appropriate useful communicative synergic effect from their use (including the amount of manufactured goods, completed jobs, provided services).

Judged by the definition of the concept of "energy conservation", its strategic goal is to increase energy efficiency in all sectors and in all settlements and in Russia as a whole. The task is to find and choose the area and measures to ensure this increase.

We think that in Russia this area is energy conservation in housing and communal services (HCS). Ongoing structural changes in Russia in the last decade in all areas of the economy necessitated the market transformation in this very critical life supporting sphere of industry and exactly with the use of energy-saving technologies. Situation in it at the moment is characterized as critical. This is due to the influence of external and internal factors and a number of problems accumulated in the period up to the market conditions and emerged as a result of market changes. Unfortunately, the level of efficiency of the industry does not correspond to modern requirements. It has accumulated problems the solution of which must be accelerated, because it is one of the most important areas of life of the population. Among the critical and fundamental issues of HCS in Russia is the restructuring of investment processes through the introduction of innovative energy-saving technologies. This restructuring, in our view, should be given preference and declared as a priority in the long- and short-term housing and communal services innovation policy in Russia.

We point out this direction in the context of the industry as an innovative trend because sustainable development of HCS organizations in the leading group may primarily be functioning only on the basis of continuous product updating, improvements in technology, perfection of business organization methods that is on the innovation vector which is fundamental in enhancing the competitiveness and efficiency of activities and cooperation of business, government and society, functioning in housing and communal services sector at all its levels.

One of the main directions of innovative development of HCS in Russia and its regions is efficiency of providing housing and communal services by identifying the reserves and the higher quality of energy use. According to Gazprombank and the working group organized by the Expert Council under the Government of the Russian Federation for HCS development, the industry annually require about $5 billion for modernization of the energy sector and the implementation of energy efficiency programs, including those in the residential sector. In this regard, the innovative development of municipal formations in energy consumption of housing services requires effective work in the field of scientific research and technological implementations based on the involvement of the private and public capital to strengthen innovation and joint activities of business, government and society. In this regard, the government should, in its legislative activities, set a vector for innovation and investment progress in Russia and its constituent territories.

The introduction of innovative projects in energy conservation sphere requires a preparatory monitoring of energy consumption in the region (such as electricity, heat, water, etc.). Its results will make it possible to select main directions of innovative investment based on identified reserves of economy or excessive consumption of resources. This paper presents the main results of a brief feasibility study for organization of production and launching new facilities designed to heat saving − insulated pipes, namely.

The introduction of energy-saving technologies should be motivated and self-organized by three-party coordinated and self-organized conditions: for authorities that determine the rules of the game in this industry; for businesses, private investors included into the industry; and for society, in which a dynamic socio-ecological-economic balance should be preserved.

Without solving energy and heat saving problems it is impossible not only efficient, stable functioning of structures and infrastructures of national systems of population, but also its reliable, safe operation and dynamic development. Without energy efficient work of HCS enterprises it is impossible to attract investment in this sector, unattainable to improve the quality of housing and communal services and targeted social protection of the public.

2. Specifications of energy conservation in Tatarstan

Let us consider the case of one of the areas of energy conservation − heat saving. The analysis showed that 1916 heat supply sources operated in Tatarstan on October, 1, 2012 with total capacity of 6.7 Gcal/h, delivering heat to population and budget organizations, which in 2011 produced 9,045.2 thousand Gcal of heat.

In 2011, the loss of heat energy for various reasons of imperfections of thermal networks in Tatarstan amounted to 3,495.0 thousand Gcal, or 10.2% of the total amount of heat supplied to the network. The heat network in need of re-innovation amounted to 904.1 km (or 25% of the total), 606.4 km of which are in dilapidated condition. In 2009, 144.4 km of networks were replaced, 133.9 km of which were dilapidated ones.

A large share of energy consumption in the Republic is taken by its capital – Kazan. The structure and the amount of heat consumption here is made up of the use of purchased heat and coolant for its own needs, the provision of services to ensure thermal comfort, or other similar services related to the use of thermal energy inside buildings, structures, premises. The city of Kazan consumed 40% of all thermal energy in Tatarstan in 2011. The current structure of housing stock of the city of Kazan is 23.1 million square meters (43.7 thousand buildings), including 12,184 apartment buildings with a total area of 20.2 million square meters. Quality of housing has the following characteristics:

- heating supplies − 96.3%;
- water supply − 84.9%;
- sanitation − 78.5%;
- hot water supply- 71.0%;
- gas supply − 94.6%.

At the moment "Program on energy conservation and energy efficiency in the Republic of Tatarstan for 2010-2015" is working in Tatarstan. Its main objectives are:

- reduction in energy and heat intensity;
- reduction of energy losses in production and consumption;
- decrease of anthropogenic impact on the environment.

A section "Energy efficiency in housing and communal services and housing stock" of this program includes measures aimed at reconstruction of HCS networks, supplying heat for residential areas and industrial constructions: replacement of existing pipelines, including hot water supply and heating.

On January 1, 2013 there was a demand in the replacement of 1808 km of pipes. Total wear-out rate of heat networks in Tatarstan is more than 40%. Each year 15-20 km of heating mains are to be replaced, but in reality only 6-8 km are relaid. Among the main reasons for this are inadequate technological processes in HCS sector in Tatarstan and in Russia as a whole.

3. Innovative technologies for the benefit of heat saving in Tatarstan

The modern century is saturated with intelligent technologies that contribute to the economy and durability of output products. Pre-insulated pipes with polyurethane foam (PUF) refer to the category of innovative products that are being introduced for the heat saving program in Tatarstan. Innovation character and advantages of insulated pipes lie in the fact that the foam keeps the heat inside the network, saving several times energy consumption compared to the traditional pipeline. Heat losses account for only 2%, while in conventional tubes this figure reaches 20%. In addition, the foam is resistant to extreme temperatures and can be used even in areas of permafrost and heat waves. Depending on the area of installation, the product is available in three forms: for warm, for cold and for temperate regions, differing in thickness of insulating layer and price. Products are resistant to damaging effects of aggressive environment and high humidity.

Foam pipes are environmentally friendly, particularly when water or other blowing agents but not Freon, as previously, is used as a blowing agent for foam filling. Current production meets the requirements of the Federal Act № 166 "On industrial safety of hazardous production facilities".

Pipes with foam are easy to install, there is often no need for laying unlined canals and wells shafts, which significantly reduces (1.2 times) the cost of installation and puts constructions into operation 2-3 times faster. Easy servicing and availability of products can 8-10 times reduce operating costs. Due to the high reliability and durability, costs of heat pipeline repair works are reduced by almost 3 times. In addition, polyurethane tubes are long on performance. Their accepted life cycle is at least 30 years. The study of pipes, which are in use in Western countries for decades, shows that their operating life is more than 50 years.

In order to satisfy the needs of Tatarstan and Kazan in the given form of pipes it is necessary to open not an experimental, but a mass production of them.

4. Feasibility study of the innovative project

According to the feasibility study of the innovative project the standard volume of production and commercialization of LLC "Teplopipe" thermal insulated pipes is 75 km of pipes per year. The expected revenue from their sale is more than 45777000 dollars. The cost structure of output is given in Figure 1.

According to the calculations, the bulk of expenses (80%) lie in tangible costs.

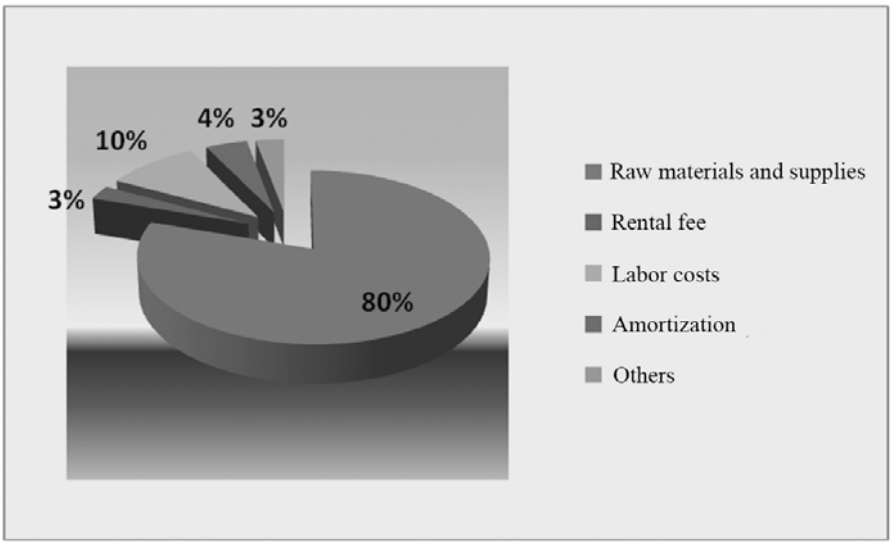

Fig. 1. The cost structure of output

Calculations of economic efficiency assessment indices of the innovative project confirm its feasibility. The evaluation was conducted with the use of indicators such as:

- Net present value of the project (NPV).
- Internal rate of return (IRR).
- Profitability index (PI).
- Payback period (simple-PP, and discounted - DPP), in years.

Table 1 shows the planned indices of income and expenditure on production and commercialization of thermal insulated pipes in LLC "Teplopipe".

Table 1. The plan of LLC "Teplopipe" income and expenditure

Indices	2014	2015	2016	2017	2018	Total, $
1. Sales revenue	1731861	2932764	4329652	4329652	4329652	17653579
2. Costs of produced pipes	1673681	2294876	3152605	3080084	3080084	17653579
3. Taxes paid prior to income tax	100421	137693	189156	184805	184805	796880
4. Income tax	-8448	100039	197578	212952	212952	715074
5. Net (reported) profit (project return)	-33793	400156	790312	851810	851810	2860295

Table 2 shows main indices of LLC "Teplopipe" activity on production release and sales of pipes.

Table 2. Main indices of LLC "Teplopipe" activity on production release and sales of pipes

Indices	2014	2015	2016	2017	2018	Total
I. Investment activity						
1. Basic production equipment	964065					975395,8
2. Pre-production costs	63062					
3. Capital formation	51057					
Investments (on the whole)	1078184					
II. Operating activity						
1. Sales result						
2. Operating income	1731861	2932764	4329652	4329652	4329652	17653579
3. Operating costs	1673681	2294876	3152605	3080084	3080084	13281331
4. Amortization	138329	138329	138329	138329	138329	691647
5. Taxes prior to income tax	100421	137693	189156	184805	184805	796880
6. Balance sheet profit	-42241	500195	15863692	15863692	15863692	48049029
7. Income tax	-8448	100039	3172738	3172738	3172738	9609806
8. Projected net profit	-33793	400156	790312	851810	851810	2860295
9. Net flow-in from the operation	104537	538485	928641	990139	990139	3551941

Table 3 shows calculations of economic efficiency of LLC "Teplopipe" investment project activity.

Table 3. Indices of economic efficiency of LLC "Teplopipe" investment project activity

Indices	2014	2015	2016	2017	2018	Total
Initial indices						
1. Investment activity outcome, $	-1078184					
2. Operating activity outcome, $	104537	538485	928641	990139	990139	3551941
3. Real money flow, $	-973647	538485	928641	990139	990139	2473757
The same, but on an accrual basis, $	-973647	-435162	493479	1483618	2473757	
4. Discounted flow of real money, $	-811373	373948	537408	477498	397915	975395,8
Performance expectations						
5. Net present value (NPV), $						975395,8
6. Internal rate of return (IRR), %						69%
7. Profitability index (PI)						1,90
8. Payback period, in years						2,47
Note: a discount factor, when discount rate is 10%	0,8333	0,6944	0,5787	0,4823	0,4019	

Thus, after the calculation the parameters were:

1. The net present value of the project (NPV), U.S. − 975395.8.
2. Internal rate of return (IRR) − 69%.
3. Profitability index (PI) – 1.91.
4. Payback period − 2.46.

The resulting data suggest that the calculated parameters satisfy the necessary criteria for a positive innovation management decision.

It is necessary to emphasize the economic effect that users of this product have. The given economic effect appears in organizations which buy pipes in the process of construction pipelines made of pipes coated with polyurethane foam.

The economic effect in terms of used methods reflects the difference in cost estimates of results and expenditure for the calculation period − the duration of the effect activity, and namely:

$$E_p = Outcomes_p - Expanditures_p, \quad (1)$$

where $Outcomes_p = \sum_{t_f}^{t_l} Outcomes_t x\alpha_t$, and (2)

$$Expenditures_p = Expenditures_p^p + Expenditures_p^a, \quad (3)$$

where E_p is an economic effect from the use of the pipes with the coating for calculation period; $Expenditures_p$ is cost estimates of expenditures, connected with this organization for a calculation period; $Outcomes_t$ is cost estimate of outcomes in t-year of the calculation period; t_f and t_l are the first and the last year of calculation period; α_t is a reduction coefficient of time transgressive outcomes and expenditure applied to a calculation year; $Expenditures_p^p$ and $Expenditures_p^a$ expenditures on production and application of pipes.

In its turn,

$$Expenditures_p^{p(u)} = \sum_{t_f}^{t_l} Expenditures_t^{p(a)} x\alpha_t = \sum_{t_f}^{t_l} (Opening\ expences_t^{p(a)} + Costs_t^{p(a)} - R_t^{p(a)})\, x\alpha_t, \quad (4)$$

where $Expenditures_p^{p(a)}$ is total expenditure in t-year; $Operating\ expanses_t^{p(a)}$ is operating expenses on using pipes in t-year; $Costs_t^{p(a)}$ is one-off costs on using pipes in t-year; $R_t^{p(a)}$ is depreciation value of released capital funds in the process of using pipes in t-year.

The reduction of costs and benefits occurring at different times to a single moment of time − the estimated year t – is necessary if the calculation period is more than one year. At the same time the year, preceding the beginning of the use of coated pipes, is taken for a target year.

When calculating the use of pipes polyurethane coated pipes were compared with the pipes with mineral cotton insulation. The economic effect of pipes with polyurethane coating consists in cost savings on:

- Construction (replacement) of the pipeline.
- Repair of the pipeline.
- Elimination of impulse piping.
- Heat loss.
- Maintenance.

The economic effect of using insulated pipes is about 71 248 dollars per 1 km in a calculation period − 30 years. Taking into account the output rate of pipes (75 km), the economic effect will be $ 5,343,596.

5. The risks of the innovative project and methods to reduce them

Risk analysis in the production of pipes with foam at LLC "Teplopipe" showed that the company can use the following methods to reduce risks:

- diversification, which implies an increase in the number of project participants, suppliers and

customers (can be used if the method does not lead to increased organizational and shipping costs);

- insurance which includes: industrial property insurance from acts of nature, insurance of products shipped from the plant during its shipment (in the case of delivery of products to the consumer, LLC "Teplopipe"), motor insurance, health insurance;
- compensation (allocation), with the creation of certain reserves: financial, material, information. The acquisition of additional information (for example, by carrying out a more detailed market research) can act as information resources. Financial reserves are organized by allocating additional funds to cover unexpected expenses. Stocks of raw products, materials and components can be regarded as material reserves.

We made an analysis of sensitivity of the innovative project to the risk factors under the following conditions:

- 10% reduction in sales result;
- 10% increase in the price of materials;
- 15% increase in investment costs.

The sensitivity of the production to these risk factors data was estimated on the basis of results of changes of such innovative project efficiency indices as the net present value of the project (NPV), internal rate of return (IRR), profitability index (PI) and payback period.

The calculations revealed that the greatest negative impact on the results of the project has a potential 10% increase in material prices. The project is less sensitive to a possible reduction of 10% in sales results. And the least impact had the possible increase in investment costs by 15%, as the rise in prices for equipment leads to an increase in depreciation and amortization expenses.

As a result of the quantitative evaluation of risks associated with the project, we can say that none of them has a critical impact on the implementation of the innovation project. These risks do not constitute a danger for the built-up production within our estimated limits.

For the development of an enterprise corporate strategy in crisis conditions main factors of external and internal environment, affecting the viability of the innovation project, were analyzed. SWOT-analysis, the results of which are presented in Figure 1, shows that the company has significant strong points to survive in the crisis. These opportunities are variable-based for the company: either to expand into new markets with low prices in such regions in Russia as Mari El, Chuvashia, Ulyanovsk, and/or to expand the range of the products and/or to ensure its export to foreign markets, and/or to increase its output by increasing the construction volume in Tatarstan and other regions of Russia and abroad. The presence of compact equipment, which can be easily dismantled, reduces the risk of depending on the renter and indicates the mobility of production. High profitability of the project reduces the threat of increased interest rates on bank loans. High efficiency of the innovative project reduces the risk of non-profits.

		External environment of an organization	
		Opportunities (O)	Threats (T)
Internal environment of an organization	Strong points (S)	**SO Field**	**ST Field**
		Opportunity to enter a new market channel with low prices (Mari El, Chuvashia, Ulyanovsk region)	Availability of compact equipment that can be easily dismantled, which reduces the risk of dependence on the renter
		The possibility to expand the range of products d = 32-1220mm	High profitability of the project reduces the threat of rise in interest rates for bank loans
		There is a steady demand in view of the fact that the products are manufactured in accordance with the Energy Conservation Program	High efficiency indices reduce the risk of non-profit
		The possibility to increase the volume of production due to increased construction in Tatarstan	
	Weak points (W)	**WO Field**	**WT Field**
		The problem of absence of a client base is solved by consulting firms that carry out market research	Partial destruction of the building due to hurricane
		Making higher the recognition ratio of the company through the use of marketing tools (advertising campaign, PR-actions, participation in exhibitions, fairs, charity events)	Equipment failure due to an unscheduled outage of energy
			The threat of failure to receive profit and inability to pay the loan and interest due to higher tax rates, increased interest loans and escalation of rent

Fig. 2. SWOT-analysis

Conclusions

The analysis showed that the managerial level of a positive innovative solution requires the identification of factors, influencing innovation activities of business, government and society in a particular space-time dimensions, be it the city of Kazan, Tatarstan, Russia or other territorial entities. In order to introduce energy-saving technologies the calculation of the efficiency of organization of production and marketing of pipes, which provide heat saving in the housing sphere was carried out. The calculation results confirm high degree of universality and feasibility of injection of investment resources in this innovative project. It should be noted that this project will provide business, government and society with realization of synergistic efficacy in specific spatial-temporal dimensions. Further development of the project considers reaching efficacy not only from the creation of production, but also from its further implementation while constructing pipelines with thermal protection that is due to the advantages of pipes with foam, which were presented above. The implementation of this project in the construction of pipelines for housing and communal services, as well as for industrial plants, will provide economic benefits in the following positions:

- savings in the construction of insulated pipes;
- cost-cutting for repair and overhaul of the pipeline;
- savings from the reduction of heat loss, etc.

According to the calculations carried out by the authors, the specific economic benefit (per 1 km of pipes) is about 100 thousand dollars. Based on the planned production volume, the sum of the expected effect gained from the introduction of pipes for the billing period will be $ 5.5 million.

As noted above, the rating of our innovative project attractiveness for the investor is measured by such indicators as profitability index, payback period, net present value, etc. However, in the specific spatial-temporal dimensions on the whole particular importance has a social component of this innovative project that helps to reduce tension in the labor market. The implementation of the project will create work places, reduce environmental tension in the region and add value to interaction of business, government and society.

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