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THE NECESSITY OF INVESTMENT DRIVEN BY OPERATIONAL CHANGES: THE CASE OF THE MUNICIPAL SECTOR

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Abstract
The green transformation promoted by the European Union (EU) affects not only infrastructure, but also managerial work organization decisions. By 2050, the EU has set a goal to decarbonize the environment and use only clean technologies for energy production. Changing legal regulations encourage investment development, which affects the work of both business entities and other organizations. The need for management skills and the change of competencies is becoming one of the most serious challenges in implementing important infrastructure projects. When it comes to the municipal energy production sector, not only the need to evaluate investment decisions, but also aspects of ensuring security of supply are highlighted. The article presents an example of the transformation of the municipal heating sector at the municipal level in Lithuania, while emphasizing the need for management changes. The possibilities of replacing worn-out heat production infrastructure are assessed, considering the goals set by the EU. Both traditional investment payback methods and innovative approaches, such as Response Surface Methodology, were employed for this purpose. The research conducted in the article showed that investments in new-generation infrastructure are inseparable from a comprehensive assessment, taking into account the future prospects of the region. The results of the article showed that it makes the most sense to undertake investments that are related to the application of new and innovative technologies, while ensuring operational flexibility. Nevertheless, it is important to consider the specific context of the location, as the most efficient solution may prove economically unviable due to site-specific characteristics and long-term prospects. The necessity of investments highlights the importance of managerial decisions – decisions on attracting investments, searching for optimization opportunities and maintaining operational competitiveness. When assessing investments, it is very important to consider the regional context and development prospects, thus finding the most favorable production technology in the long term.
KEY WORDS: energy transformation, management solutions, municipality, rural development
JEL Classification: O18, Q20, P25

Introduction

The need to assess the performance of new generation equipment and the resulting change in management decisions arises from the European Union's position on environmental protection. The EU has long based its activities on green technologies, environmental protection and the recently added component of energy independence. The European Union's policy in the 2021-2027 perspective has become clearly based on the European Green Deal. The course included specific and targeted transformation directions in the cases of decarbonization of energy production, agriculture, and transport. At the same time, this must create conditions for energy independence by reducing the import of energy resources from Third World countries. In quantitative terms, the goal of reducing greenhouse gas emissions by 80–95% by 2050 was set (European Commission, 2025). Preparatory work for the adoption of directives took place until 2020, which regulated the following aspects:

- Directive 2009/28/EC of the European Parliament and of the Council on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC6 Directive 2009/29/EC of the European Parliament and of the Council amending Directive 2003/87/EC so as to improve and extend the Community greenhouse gas emission allowance trading scheme (EUR-Lex, 2009);
- Directive 2010/75/EU of the European Parliament and of the Council on industrial emissions (integrated pollution prevention and control) (EUR-Lex, 2010).

In particular, heat production is considered part of the overall decarbonization plan in this case. This is related to the uneven demand for heat production in the EU. In the case of decarbonization of heat production, the main focus is on separate communications dedicated to this sector:

- European Commission Communication "Energy 2020. A strategy for competitive, sustainable and secure energy". Target indicator – achieving the 2/3 clean heat production target, increasing the share of centralization and cogeneration (combined heat and power production) (EUR-Lex, 2020).
- European Commission Communication "Stimulating a climate-neutral economy: A strategy for the integration of the EU energy system". The main emphasis is on increasing the influence of heat pumps, while expanding the production of green electricity in decentralized heat production sources (European Committee of the Regions, 2021).

The EU's position on the green transformation is supported by the allocation of structural funds, the promotion of innovation, as well as the development of electricity networks. The green transformation was primarily supported by the installation of wind farms (Barthelmie & Pryor, 2021). Later, with the solar energy breakthrough, more and more areas in the Baltic States, Poland, Italy, Germany, and Romania were allocated for the installation of solar panels (Lebedeva et al, 2025; Igliński et al, 2023; Raihan et al, 2024; Gómez-Calvet & Gomez-Calvet, 2025; Prăvălie et al, 2022). These technologies are made even more efficient by Battery Energy Storage System (BESS) systems, which create conditions for storing energy (Mohamad et al, 2021; Tejero-Gómez, & Bayod-Rújula, 2023). Biomass utilization remains important in terms of biowaste utilization (SOURCE), and new generation biomethane production technologies allow for the decarbonization of the transport sector (Noussan et al, 2024). These changes significantly affect the management systems of companies managing this infrastructure – there is a need to have strong technology and remote management departments, as well as strong energy sales specialists working with virtual electricity exchanges (Li, 2024; Zhou et al, 2025).

In addition to the development of new infrastructure, the search for efficiency is also of great importance. They are promoted comprehensively and widely. The most relevant EU directive is related to increasing energy efficiency. Directive (EU) 2023/1791 regulates the key directions that will be followed to change and improve the energy system. The key goal is the decarbonization of the energy system in two directions - the use of new green technologies and reducing the amount of energy consumed. A separate section summarizes actions in district heating (DH) systems focused on decarbonization and strengthening centralization. The focus is on network development, although production capacities can be divided into smaller ones focused on individual city districts. In addition, in order to better utilize the DH infrastructure, heat supply in winter generates synergy with cooling supply in summer. Combining these two solutions will improve the payback periods of technologies and the utilization of infrastructure.

The main problem is how, based on the EU Green Deal, to conduct an investment assessment in municipal heat production companies, providing them with opportunities not only to replace worn-out infrastructure, but also to create a basis for the use of new technologies and the implementation of activities.

The aim of the article is to assess the possibilities of regional, remote areas to transform energy systems using new and relevant technologies that correspond to prevailing international trends.

Literature review

The consequences of climate change are increasingly felt around the world. Heat waves, sudden snowfalls, floods are just some of the evidences of changing weather. One of the main reasons for this phenomenon is the pollution created by the energy system. The use of fossil fuels over the past 200 years has fundamentally changed the global environmental situation. Growing economic prosperity has fueled the growth of pollution. Due to the late concern for the environmental situation, actions to stop climate change are necessary and urgent. This coincides with the rapid level of urbanization and the deterioration of the economic and social situation of regions. The solution to both of these problems can be complex, including energy transformation activities in regional areas. The use of renewable energy resources involves the combination of various technologies in order to increase the production of green energy. This in itself creates a direction for the decentralization of the energy system, since in the case of electricity generation, the influence of centralized production sources is reduced. Energy transformation involves the combination of different technologies related to energy production and storage. At the same time, new energy production derivatives are emerging, such as cooling produced by centralized heat production facilities. One of the essential distinctive features of energy production based on renewable resources is the ability to use currently unexploited resources. This is related to the construction of wind and solar power plants on unused land areas, the use of biomass waste, and the production of biomethane from organic waste. Land resources and waste are concentrated in regions whose potential is currently not fully exploited. The use of these resources in regions would create conditions for new business activities – profitable land lease, biomass exploitation, and the provision of maintenance services. In addition, regions are characterized by unexploited electricity and gas networks, thus further promoting energy transformation.

The energy sector, including the field of heat production, has undergone significant changes in recent years. Relevant technological combinations are being sought that would allow not only to engage in core production activities but also provide a basis for new business initiatives and energy security. This is especially visible in the field of heat production - synergies with the water treatment sector are being sought, and electricity generation technologies are also being implemented. Although the heat sector is often treated as quite specific and narrow, the latest technological solutions allow the production of not only centralized heat in winter but also centralized coolness in summer. This will expand the need for managerial competencies required by a business entity, in connection with the expanding amplitude of activities and growing income levels.

Management and investment challenges in the heat generation sector include complex aspects. When analyzing the need to develop managerial competencies, it is emphasized that it is necessary to develop cybersecurity and data protection competencies (Georgiadou et al, 2023; Pirta-Dreimane et al, 2024). As energy systems become increasingly digital, with the emergence of remote-control capabilities, there is also a risk that these systems can be taken over by hostile entities. In order to avoid these risks, managerial competencies must be constantly strengthened (Karaeva & Magaril, 2025). This is inevitably related to the need for investment, since each new investment must be supported by the emergence of managerial changes. In the case of the European Union, the existing General Data Protection Regulation (GDPR) creates the need not only to strengthen the infrastructure, but also to develop data management competencies. In the case of heat generation, the necessary competencies are mainly related to customer data management (Temelkovski, Temjanovski, 2018; Hanushchak-Yefimenko, & Arabuli, 2022). However, fundamental decisions on how to supplement the managerial competencies in the company are related to the chosen heat production method. Accordingly, the need for competencies and the possibilities of attracting them through employment contracts or purchasing relevant services must be assessed.

District heating technologies involve the use of various energy sources (biomass, solar energy, waste heat, heat pumps) in large boiler houses to efficiently produce and supply heat to building complexes, reducing pollution, increasing reliability and implementing innovative solutions, such as the integration of renewable energy, to reduce fossil fuel dependence. Key technologies and sources adapted to the Lithuanian case:

- Biomass. A local renewable resource that allows for a significant reduction in CO2 emissions compared to fossil fuels. Its trade is concentrated on the *Baltpool* energy exchange, based on which a unified Baltic biomass market has been created.
- Solar energy. The independent use of solar energy for heat production is problematic in terms of costs. Solar power plants are integrated into boiler houses, using sunlight energy for the needs of the boiler house or for heating small volumes of water (Meena et al, 2022). The use of solar energy is most effective when energy storage batteries are used. In this case, external competencies can be used for equipment maintenance by purchasing equipment maintenance services.
- Secondary energy sources. The heat released during production processes is used for heating networks. The most popular method of waste heat recovery used in Lithuania is condensing economizers, which cool the gases emitted into the atmosphere through chimneys. The use of condensing economizers is optimal when the boiler capacity reaches at least 5 megawatts (MW) (Huang et al, 2025). However, such a solution is relevant for larger areas (> 30,000 inhabitants), since a significant initial production capacity is required for the economizer to operate, which in turn requires a stable demand for heat energy.
- Heat pumps. Use ambient heat (from air, water, ground) and transfer it to the heating network in order to reduce the need for fossil fuels. In this case, it is necessary to carry out independent electricity generation activities, supplying heat pumps with the necessary amount of electricity. Heat pumps can be used as a technology that complements a centralized heat production system. Absorption heat pumps are already used in large (over 70 thousand consumers) heat supply systems.

These solutions can be universal, adaptable to municipalities of different sizes and agglomerations with a population of 5,000-500,000. However, the main challenges are recorded in municipalities with a smaller population that do not have prospects for increasing the number of heat consumers (Martinez et al, 2022). In these municipalities, maintaining infrastructure is becoming increasingly expensive, since it is impossible to take advantage of economies of scale (Reda et al, 2021). It is difficult for such municipalities to attract external financing, and existing infrastructure is used longer than its rational service life (Stec et al, 2023). Another fundamental problem is the lack of different technologies in current areas. Due to the lack of management knowledge in smaller companies, there is a risk that the wrong technological solution will be chosen, which may be either too small or too large in capacity (Świerszcz, 2023). Devices with too large a capacity may be used irrationally, and their maintenance costs may increase the price of heat. Too small facilities can create a risk of energy supply disruptions during the coldest period of the year. Currently, there is a tendency that different development situations in the heat sector are studied quite limitedly (Sayegh et al, 2017; Bush et al, 2016; Tereshchenko, & Nord, 2018; Zajacs, Borodiņecs, 2019). Energy systems of larger cities (>500,000 inhabitants) are studied based on the principle of technology integrity and the use of scale. Smaller cities lack a critical approach, good science and practical examples that would allow making responsible investment decisions. The existence of such studies would allow filling both technological and managerial gaps in making investment decisions.

For the sake of an objective assessment of future investments, an objective analysis is required, which includes not only possible current needs, but also future prospects for the development of the region. An objective assessment of the situation will allow creating a resilient infrastructure that is beneficial to the area throughout its entire period of operation. When assessing methodological aspects, it is important to emphasize that in addition to the introduction of theoretical models, it is mandatory to assess current raw material data, thus creating the opportunity to obtain objective future projections. Since in this case the example of a municipal enterprise is being assessed, it is noted that the enterprise operates in a regulated market, and the price of its final product – heat – is determined centrally based on the actual costs incurred by the enterprise. This limits the business entity's ability to unilaterally change energy prices, while at the same time establishing clear projections of investment payback.

Methodology

The analysis uses data from a municipal heat production company located in one of the Lithuanian municipalities. The company is a relatively small-sized company that has produced about 15,000 MWh of heat energy in recent years. Over the past 5 years, the volume of heat production has decreased by 25 percent due to building renovation and a lack of new customers. The existing production infrastructure is functional, but inflexible, unable to fully adapt to changes in weather conditions and periods when full production capacity is not required. The company operates in one city, the population of which in 2025 reached 5,120. Currently, heat production is carried out based on biomass - 100 percent of it was consumed in 2025. The company also has a reserve heat production units using fuel oil and wood pellets. The main goal is to assess the possibilities of using more flexible production technologies, which would allow both energy production and expansion of the range of services.

To assess economic indicators, classic indicators recognized by state and business credit institutions are used – net present value (NPV) and internal rate of return (IRR). These indicators allow for an objective assessment of project costs and generated income throughout the entire project implementation period. The costs included in calculating NPV and IRR include annual maintenance costs, interest costs, as well as other internal and external costs. Evaluation actions will be carried out for two technologies – a cogeneration heat production facility (producing heat and electricity simultaneously) and flexible heat production systems using biomass. Possible assumptions are established for the implementation of both technologies, which will affect economic indicators and technical aspects, adapted to the analyzed case. When assessing the assumptions, the principle of skepticism is followed – exceptional price values formed due to external circumstances are not assessed, instead, using basic, conservative price values that maintain the profitability of suppliers' levels (in the case of energy prices). In the case of technology cost analysis, commercial offers and national heat market regulatory norms are evaluated. Response surface methodology analysis is used as a substantiating factor, based on existing capacities of similar size. This aim is to determine optimal and competitive energy price levels.

Biomass price component

It can be stated that since 2023, there has been a stable biomass market in Lithuania, meeting the needs of both biomass buyers and sellers. The biomass price that had prevailed until then (~11 EUR/MWh) (VERT, 2026) was determined by biomass imports from Belarus. This reduced the competitiveness of local producers, which is why almost a third of biomass producers withdrew from the sector (State Data Agency, 2026). It is generally accepted that a healthy price level for both biomass producers and heat industry companies has been established at 25 EUR/MWh. It is likely that this or a slightly lower price level will remain in the future. The increase in the price level will be influenced by seasonality, but the influence of this phenomenon will be reduced by the strategy of heat industry companies to store part of their biomass in warehouses. Figure 1. The biomass price is projected based on three scenarios, assuming that the biomass price will increase by about 3-5 percent annually.

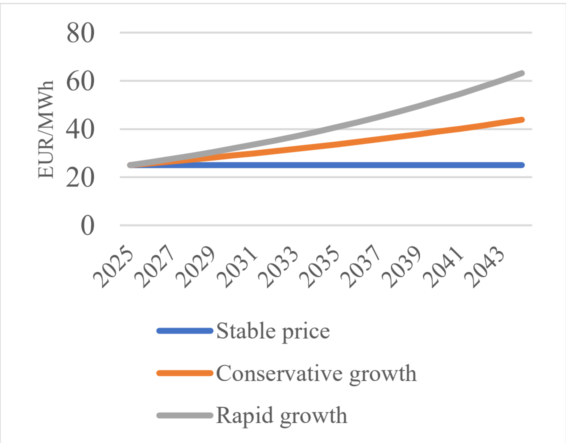

Fig. 1. Scenarios of biomass price

The average biomass price is determined according to three scenarios for a 20-year period:

- Stable scenario – EUR 25
- Conservative growth scenario – EUR 34
- Rapid growth scenario – EUR 41.

The dynamics of the price of biomass pellets is not assessed due to the fundamentally changed operating assumptions – a significant decrease in the number of local pellet producers and the resulting instability of supply and prices. From a short-term perspective, without encouraging pellet production volumes, it is necessary to change pellet-fired boilers to other technologies. There are no assumptions related to the increase in pellet production volumes in Lithuania.

Electricity price component

The electricity market is dominated by price uncertainty, determined by insufficient electricity production volumes in Lithuania. Due to the growing use of renewable resources and insufficient electricity storage capacities, price jumps are visible, which significantly increase the costs of business entities and residents. In order to generate own electricity, it is necessary to assess the fact that the peaks of electricity production and consumption in the company are essentially separated. For this purpose, it is necessary to install energy storage capacities. The electricity price trends presented in Fig. 2 are preliminary, assuming that price differences will be equalized through own electricity storage facilities. The starting point is the price of EUR 70, which indicates stability in the electricity price market.

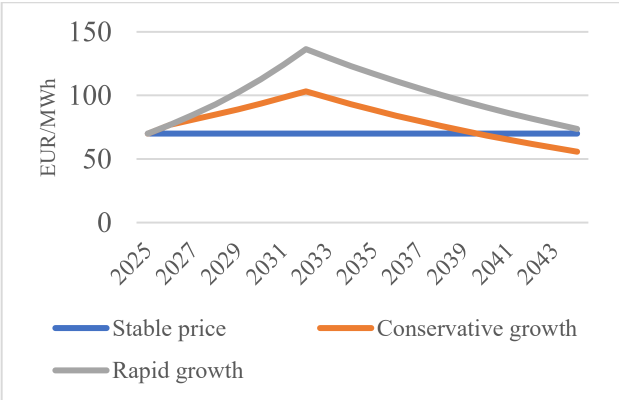

Fig. 2. Scenarios of electricity price

The following assumptions are used for further calculations:

- Until 2033, a conservative price change may reach 5% per year, a rapid change – 10% per year.
- After 2033, if the electricity production targets specified in the National Energy Independence Strategy will be achieved, a 5% decrease in electricity prices is projected in both cases.
- Hourly price changes are not evaluated due to the complexity of the process, assuming the need to have own energy storage facilities or carry out hedging transactions.

Employees and organizational structure

No significant changes in personnel are planned. The selected technology is close to the solutions currently used, which ensures that the competences accumulated in the company over many years will be properly utilized. In the case of the installation of heat pumps or solar collectors, equipment maintenance services, which will be purchased from outside, will be of great importance. The new equipment will allow for better utilization of existing employees, as it will work more efficiently due to its novelty. Due to the unchanged production mode (the company does not supply hot water), no significant changes in work organization are expected. In individual cases, some employees may contribute to the apartment building administration department at certain times, if additional work is needed.

WACC evaluation

Due to the activities of the analyzed company in a regulated market, any investments must be coordinated with national authorities. According to a pre-established methodology (Table 1), the weighted average cost of capital (WACC) is calculated, which will determine the rate of return on investments set in the company. Due to restrictions on investment returns, the WACC indicator used reflects the regulated activity environment in which the company operates.

Table 1. Indicators required for calculating WACC in the case of a heat production company (VERT, 2026)

Indicator	Value
Return on equity (R_e) for renewable energy	7,846 proc.
Debt share (WD) (optimal capital structure)	50 proc.
Equity share (WE) (optimal capital structure)	50 proc.
Corporate tax rate (m)	0,17
Risk-free rate of return (R_f)	3,546 proc.
Equity risk premium (R_{erp})	5 proc.
Relative risk measure (weighted β) for renewable energy	0,860
Cost of equity	8,270
WACC	**7,125**

Table 2 sets out the technical assumptions, which include biomass utilization technologies. In both cases, commercial offers were received to justify the price, focused on the energy requirements of the analyzed company. The variable costs presented in the table are related to the operation and maintenance costs of the equipment. They can increase or decrease depending on the prevailing equipment maintenance policy and the distribution of responsibilities in the company.

Table 2. Technical assumptions for the assessment of heat and electricity generation facilities

	Investment, EUR/kWh (heat)	**Variable costs, EUR/MWh**	**Number of commercial offers**
Biomass cogeneration plant	1000	20	2
Biomass cogeneration plant for heat production (with economizer)	750	15	3
	Investment, EUR/kWh (electricity)	**Variable costs, EUR/MWh**	**Number of commercial offers**
Biomass cogeneration plant	500	5	2

Results and discussion

First, the use of cogeneration solutions is analyzed. This would allow the company to expand its activities - both heat and electricity would be produced at the same time. Such a solution is mainly applied in agglomerated areas with a constant need for heat. At the moment, when heat energy can be converted into centralized cooling, the cogeneration solution can significantly affect the production and economic results of a business entity.

When evaluating cogeneration technology in the context of this research, it can be stated that this step is limited by the optimal capacity of the equipment and compatibility with the city's energy system. During cogeneration, heat is produced, and electricity is obtained as waste energy. In the case of the analyzed company, the active production phase is limited to the heating season (October-April), since hot water supply is not carried out. Due to the lack of industrial enterprises, the possibility of supplying heat energy during the summer period is limited. When evaluating these aspects, it can be stated that such a power plant could operate effectively for about 6 months. per year. To determine the optimal price and production capacity, the Response surface methodology is used, with the help of which different operating parameters will be studied in the case of cogeneration power plants. Heat production facilities (3.6 and 9 MW of heat capacity) available on the market, which can also produce electricity (1,2,3 MW of electricity capacity), are used for the assessment. The statistical calculations presented in Table 3 show the suitability of the model for further research. The independent variables are heat and electricity capacity indicators, and the dependent variable is the heat price.

Table 3. Initial information for the heat and electricity capacity and heat price model

Source	Sum of Squares	df	Mean Square	F-value	p-value	
Model	4,38	2	2,19	21,75	0,0002	Significant
A-Heat price	2,94	1	2,94	29,17	0,0003	
B-Electricity price	0,0315	1	0,0315	0,3130	0,5882	
Residual	1,01	10	0,1008			
Lack of Fit	0,2628	4	0,0657	0,5291	0,7200	Non-significant
Pure Error	0,7450	6	0,1242			
Correlation Total	5,39	12				

Table 4 presents statistical calculations of heat and electricity capacity and electricity cost in cogeneration power plants. The axis of cost assessment is the currently acceptable biomass price level - 25 EUR/MWh. With the growth of biomass prices, the cost level may significantly change in the direction of increasing electricity prices. During the analysis, a trend was observed that low-power boilers are the most uncompetitive in terms of electricity prices. The electricity produced in them is characterized by a high cost and low production volume. After considering balancing and other network fees, the profitability of such power plants is even lower.

Table 4. Diagnostics of the heat and electricity capacity and electricity and heat price model

Std. Dev.	0,3175	**R^2**	0,9531
Mean	7,84	**Adjusted R^2**	0,9357
C.V. %	4,05	**Predicted R^2**	0,9195
		Adeq Precision	11,9231

According to the analysis performed, the average price of heat and electricity in cogeneration power plants is determined. When evaluating the smallest cogeneration power plants available on the market, it was assumed that the most efficient of them generate 9 MW of heat and 2 MW of electricity. This allowed determining the optimal price of heat and produced electricity, which can be obtained using cogeneration facilities. Table 5 shows that at a biomass price of 25 EUR/MWh, heat can be produced at a high level of competitiveness, but the price of electricity produced, compared to other production methods, is uncompetitive. Considering that in the case of the analyzed business entity, the optimal power of the heat boiler is half that of the boiler, the solution of a cogeneration solution based on the use of biomass is economically unreasonable. As the price of biomass rises, the price of electricity will grow even more, therefore the competitiveness of the electricity produced in the market would be limited.

Table 5. Optimal energy prices for heat and electricity capacity and electricity and heat price model

Analysis	Optimal point
Heat price	7,96031
Electricity price	9,61149

In order to maintain the stability of the analyzed heat production company's operations and create conditions for more flexible energy production, the possibilities of using the analyzed integrated biomass power plant with an economizer are further analyzed. It is emphasized that according to EU directives, when installing new biomass boilers, at least 105 percent of the useful operating coefficients must be achieved, as well as conservative pollution standards must be met. This ensures that investments will be directed at the latest technological solutions that will allow for efficient production of heat energy while minimizing pollution. The price of biomass used in the calculations is presented in Table 6. The optimal 15-year payback period is assessed.

Table 6. Biomass price scenarios for biomass power plant payback calculations

Year	Stable price	Average price	Higher price
2025	25	25	25
2026	25	25,8	26,3
2027	25	26,5	27,6
2028	25	27,3	28,9
2029	25	28,1	30,4
2030	25	29,0	31,9
2031	25	29,9	33,5
2032	25	30,7	35,2
2033	25	31,7	36,9
2034	25	32,6	38,8
2035	25	33,6	40,7
2036	25	34,6	42,8
2037	25	35,6	44,9
2038	25	36,7	47,1
2039	25	37,8	49,5

Other conditions:

- Estimated biomass boiler capacity – 2.95 MW,
- 25 percent grant regime applied/not applied,
- Municipal support not foreseen,
- WACC applied – 7.125 percent

To assess economic indicators, classic indicators recognized by state and business credit institutions are used – net present value (NPV) and internal rate of return (IRR). These indicators allow an objective assessment of project costs and generated income throughout the entire project implementation period. Table 7 presents preliminary calculations, which were made considering the assumption that the national development bank ILTE will allocate part of the funds required for the installation of the boiler house in the form of a grant. The costs included in calculating NPV and IRR include annual maintenance costs, interest costs, as well as other internal and external costs.

Table 7. Economic evaluation indicators of the installation of a new biomass power plant with an economizer are analyzed in the DH system of the company

Indicator	Value	Stable price	Average price	Higher price
Nominal power of new heating boiler, MW	2,95			
Investment amount, million EUR	2,6			
Amount of possible non-refundable grant, million EUR	0,6			
Net present value, EUR (without grant)		-22822	162590	339436
Internal rate of return, % (without grant)		6,94	8,25	9,36
Net present value, EUR (with grant)		395646	581058	757904
Internal rate of return, % (with grant)		10,19	11,71	12,75

In this case, the methods chosen allowed for a comprehensive assessment of individual technologies. In case of doubts about the feasibility of cogeneration technology in smaller areas, the decision was made to conduct a preliminary assessment based on Response Surface Methodology (RSM). Having obtained the result that the heat price after the investment would be twice as high as the current one, the decision was made not to propose this technology for further assessment. The application of RSM in energy is currently quite rare, since it is based on traditional investment assessment tools, and in addition, such an assessment requires more data. The analysis conducted by Ahmed et al (2025) showed that there are different methods for assessing energy investments, but RSM is not mentioned among them. In this case, the focus is on cost-benefit analysis methods that show payback periods, but in-depth forecasts describing the efficiency of the selected technology are avoided. The application of RSM can expand the understanding of energy system assessment methods, thus making investment actions more responsible.

When analyzing scientific literature, it is found that energy projects are evaluated mainly through the prism of costs. This is done for two reasons. First, it is related to growing pollution taxes. Second, in the case of the energy business, revenues can be difficult to predict due to trading on the open market (Björnebo et al, 2018). However, such an approach is not suitable for renewable energy systems, since in their case pollution taxes are not relevant, and in addition, revenues can be forecast based on different scenarios. They must include aspects related to the price dynamics of the last 5 years, as well as price shocks that occurred at that time. This will allow maintaining objectivity, while creating conditions for more accurate determination of the payback period of investments.

Another aspect that unites existing energy system research is a narrow approach and the limitations of the use of existing methodological solutions. There is a lack of universal models that would allow for a comprehensive assessment of energy systems of different sizes, since currently either large, agglomerated energy systems are assessed, or rural energy systems that operate in small communities. In the latter case, the cost component is particularly emphasized when large energy systems are analyzed for opportunities to generate higher income (Hendricks et al, 2016). The article prepared by the research group has formed a universal methodology, while simultaneously analyzing medium-sized regional areas located in municipal centers. This achieves a large assessment coverage, creates a comparable assessment base, while maintaining the universality of the model.

Energy system conversion studies, which simultaneously assess the economic and management components, will be relevant in the future, as climate change will dictate the conditions for large-scale changes. Medium-sized energy system conversion studies are important in that the transformation of these territories can stimulate positive changes on a national scale, especially in larger areas. At the same time, changes can bring positive shifts in business management - attracting new specialists, changing management methods, thus in turn increasing financial results, reputation level and economic power.

Conclusions

The prevailing legal regulation in the heat production sector is no longer limited to the modernization of heating systems alone. Strategic importance is also given to energy efficiency initiatives, which will significantly affect the income of companies in the heat sector. In the case analyzed, the decrease in income may be programmed not only by the pace of urban development, but also by the expanding energy efficiency initiatives among the company's consumers. European Union legal acts are implemented in Lithuania through the Law on the Heat Industry of the Republic of Lithuania and the National Energy Independence Strategy. The latter envisages an important role for the heat sector in strengthening the energy system of the entire country and increasing local electricity consumption. This concerns both the promotion of cogeneration solutions and the introduction of new technologies, such as heat pumps, into energy systems.

The company under analysis has been using local renewable biomass as the main source of heat production for many years. This has allowed the company to ensure stable and low heat prices for the residents of the serviced area. However, the approaching end of the service life of the company's heat production facilities creates financial and technological challenges. The need to choose flexible production technologies and find adequate financing solutions creates a trend of uncertainty in operations. Delayed investments can lead to growing maintenance costs, but the search for favorable financing sources is a key factor in the success of the modernization of the infrastructure of the company under analysis. In order to find optimal modernization solutions that would increase the efficiency of the company's operations, a technical-economic assessment is necessary, while taking into account the changing dynamics of heat consumption in the analyzed area during the strategic period.

When assessing the necessity of installing a new heating boiler, it should be stated that the cogeneration solution is inappropriate for the analyzed case. The main reasons are related to the insufficient cogeneration capacity (3 MW of heat output instead of the required at least 9 MW) and the intermittent operation of the boiler house (the boiler house operates only during the heating season). Investments in cogeneration technology would be excessive and would not bring economic benefits to either the company or consumers. The installation of a heat pump should be considered as a factor increasing the flexibility of the heating system, but for this it is necessary to develop integrated electricity management solutions – own production and storage capacities.

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