

VILNIUS UNIVERSITY

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**ANALYSIS AND EVALUATION OF ENERGY EFFICIENCY
INVESTMENTS IN THE HOUSING SECTOR**

Summary of the doctoral dissertation
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VILNIAUS UNIVERSITETAS

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**INVESTICIJŲ ENERGIJOS VARTOJIMO EFEKTYVUMUI DIDINTI
BŪSTO SEKTORIUJE ANALIZĖ IR VERTINIMAS**

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INTRODUCTION

Relevance of the topic. Energy plays an important role in every person's daily life, as well as at the national level in pursuance of the goals of energy policy. Heat is the most widely spread type of energy. Households are one of the largest energy consumers throughout most of the world, with most energy consumption falling to household heating and cooling, depending on the region. The consumption of energy resources is also directly linked with environmental problems as it determines the release of carbon dioxide (hereinafter referred to as CO₂), being the main greenhouse gas causing global warming, into the environment. The increase in heat energy efficiency is a measure of paramount importance in combating climate change, with a limited impact on the increase in energy pricing; it also influences the country's energy dependence on gas import. The said challenges and possibilities determine that the issue of enhancing energy efficiency in the housing sector is gaining momentum in the country's economic policy targeted at competitive economy and sustainable development goals.

The increasing need for an efficient management of the housing stock in European cities is mostly apparent in the region of the new European Union (hereinafter referred to as the EU) Member States, showing a considerably higher intensity of energy consumption compared to the old EU Member States. The countries of Central and Eastern Europe (hereinafter referred to as CEE) have an immense potential for enhancing energy efficiency – most of the region's multi-apartment buildings built as part of the mass industrial Soviet construction are pending renovation. The process of transitioning to a market economy had a significant impact on the condition of the region's housing stock. On the one hand, the general economic development fuelled the housing policy changes through sector restructuring and the transfer of housing property rights to residents. On the other hand, the economic recession, the decrease in income and the growing unemployment added to the deteriorating condition of the housing stock built at the times of cheap energy resources and lacking adequate maintenance for a long time.

The thesis focuses on the case of the use of energy resources in the Lithuanian housing sector. Efficient consumption of energy resources and energy is one of the key long-term strategic goals of the Lithuanian energy sector given that energy saving constitutes an inevitable challenge at the level of the country and each resident. Even though the CEE countries choose different economic packages of measures targeted at energy saving outcomes and the methods ensuring safe and healthy housing, the level of energy consumption and CO₂ emissions falling to the buildings in Lithuania reflects the tendencies apparent in the group of countries, while the measures employed in the housing policy show the general tendencies of the region. The paper assumes that the major conclusions are applicable to all the CEE countries implementing or intending to implement similar initiatives promoting energy efficiency in the housing sector.

Approximately 96% of multi-apartment buildings in Lithuania were built before 1993 and are neither cost-effective nor energy-efficient. Of them, about 24,000 are pending renovation (modernisation). The estimated investment demand amounts to LTL 46 billion. As a result of market imperfections, lacking information and vast

initial investments, isolated homeowners' decisions do not determine the scope of actions and the impact on the country's economic policy. The allocation of financing from the public sector for energy-efficiency solutions in the housing sector does not only contribute to reducing energy bills of public authorities but also a more effective use of the finances collected from the residents in the form of taxes. To implement the renovation of public housing demanding large-scale financial resources, national modernisation programmes are required.

In the 21st century the issue of energy efficiency has not only become the dominant object in the discourse of European national economic policies but also an attractive topic for populist political aspirations. The thesis attempts to approach the aspect of energy efficiency in a complex manner by evaluating the theoretical and practical aspects relating to the research object. The thesis is based on the analysis of the imperfections of the market of energy efficiency in the housing sector, the measures applied by the state in the framework of the economic policy and their impact on the economic, social and environmental development. What and how the state should do to ensure efficient implementation of the housing renovation policy enhancing energy efficiency, as well as how to evaluate the state intervention in the housing renovation sector, are the key questions addressed in the thesis.

The doctoral thesis seeks to reveal the multi-sidedness and complexity of the housing renovation process and to evaluate investments in energy efficiency measures relating to the actions of public policy targeted at promoting investment opportunities, by simultaneously stimulating the impact on social, economic, as well as environmental sectors. The complex study of the three aspects is related to the concept of sustainable development, which took the dominant position in the range of topics on the increase in energy efficiency and urban development addressed across the globe and is elaborated on in this paper. The thesis relies on the theory, according to which economics, social needs and environment are physically linked through the circulation of substances and energy.

Research problem. Despite the existence of a number of studies addressing energy efficiency in the housing sector in scientific literature, they fail to give a complete picture of the outcomes of the decisions taken at the national level on the social and economic development of the country; they also limit with an episodic attempts to explain the role of increasing public and private energy efficiency investments in the housing sector in the welfare economics theory. Detailed evaluation of the actions of public economic policy as well as development of the financial, economic, social and environmental benefit evaluation model and methodology for energy efficiency investments in the sector of multi-apartment buildings would contribute to fill the gap in scientific literature.

Research object – energy efficiency investments in multi-apartment buildings.

Research goal – to analyse and evaluate the actions of the public economic policy targeted at the results in energy efficiency markets and the development of the financial, economic, social and environmental benefit evaluation model for energy efficiency investments in the sector of multi-apartment buildings.

The **objectives** set in the thesis:

1. To reveal the importance of energy efficiency investments in the context of the country's economic policy.

2. To evaluate the importance of energy efficiency in the housing sector and to analyse the characteristics of household energy consumption in multi-apartment buildings.
3. To provide a theoretical justification of the benefit of investments in energy efficiency in the housing sector to the country.
4. To justify the governmental intervention in the energy efficiency market in the context of the welfare economics theory and to analyse the imperfections of the market in relation to energy efficiency measures in the housing sector.
5. To analyse and summarise the concept of sustainable development in economic literature and its relationship with energy efficiency measures in the housing sector.
6. To evaluate the interrelations of the city as a public, economic and structural-technical organism and housing as the main place of social being, and to analyse the problems of contemporary cities of the EU and the aspects of sustainable development.
7. To analyse energy efficiency investment programmes implemented in the EU Member States, as well as the initiatives brought forward at the EU level.
8. To carry out a qualitative evaluation of the national programme for renovation of multi-apartment buildings implemented in Lithuania.
9. To prepare the research methodology for energy efficiency investments in the housing sector.
10. To develop an evaluation model for energy efficiency investments in the housing sector.
11. To carry out an empirical evaluation of energy efficiency investments in the housing sector and to provide the forecasts of financial, economic, social and environmental benefit.

Research methods. The research is based on a complex approach towards the research object and its constituent parts. The general scientific and special research methods were used to investigate the research problem and to obtain the theoretical and practical results: analysis and systemisation of scientific literature, comparative analysis, analysis of secondary sources, logical model, other qualitative methods, statistical data analysis, grouping, graphical modelling. A separate group of methods was applied to foresee the financial, economic, social and environmental benefit of the housing renovation sector: 1) monitoring source analysis; 2) input-output analysis enabling the analysis of the changes in economic activity across all sectors in a direct or indirect relation to the intervention of the public sector. With regard to the intensity of activities in each sector, the number of the jobs created or abolished and the net effect on employment were calculated. The input-output analysis also helped to measure the impact of the change in the final household consumption. MS Excel 2010 tables and mathematical programming software package MatLab 7.12 were used for statistical empirical processing of research results.

Different scientific, statistical and methodological literature was analysed in the doctoral thesis. The doctoral thesis mostly relied on Lithuanian scientific literature

and that of other CEE countries. The main sources in use are the following: scientific articles dealing with the theoretical and practical aspects of the state intervention in the housing sector; empirical research reflecting the most up-to-date results of energy efficiency research studies; legislation regulating the promotion of energy efficiency in the EU and the implementation of the housing renovation policy in Lithuania; EU research on the implementation of energy efficiency measures in the EU Member States; conference material and other sources specified in the references.

Research limitations. It is acknowledged that the shortage of available statistical data makes it very difficult to obtain a precise evaluation of the impact of energy efficiency programmes. The evaluation of financial, economic, social and environmental benefit of energy efficiency investments in the housing sector limits with historical statistical data and the accomplished monitoring of the programme for renovation of multi-apartment buildings without a survey of additional related sectors or other qualitative methods which would potentially provide a more comprehensive picture of the phenomenon under analysis and reveal additional benefit. Furthermore, it is difficult to forecast the pace of implementation of investments dedicated to the multi-apartment housing renovation sector considering that the designed financial instrument and the legal basis of financing and implementation of renovation projects are still new and continuously revised in Lithuania. Therefore, the empirical benefit evaluation presented and the results obtained should be interpreted with due regard to the afore-mentioned risks.

Scientific novelty: theoretical and practical significance. The thesis does not limit with the analysis of energy efficiency investments in the housing sector in application terms but also reveals and justifies the theoretical preconditions of the state intervention in the energy efficiency sector. The doctoral thesis is related to the analysis of the theoretical preconditions of the state intervention in the energy efficiency sector, specifically the increase of energy efficiency in the housing sector. The study of the instruments of state intervention in the housing sector carried out in Lithuania to this day have limited with their development and application aspects while the theoretical evaluation of the national housing renovation policy has remained outside the scope of research (or limited with individual aspects only). The thesis presents a consistent and systematic analysis of the public economic solutions in the area of increasing energy efficiency in the housing sector, by revealing a comprehensive impact on the country's economic, social and environmental development. To this day, the research limited with isolated attempts to investigate the social, economic and environmental impact of the housing sector renovation programmes in certain periods or by focusing on individual aspects of enhancing energy efficiency.

The doctoral thesis explores a new financing mechanism for the renovation of the housing sector (based on the logic of the revolving financial fund), in contrast to most of the research studies in Lithuania which limit with the analysis of the logic of the grant-based national housing policy. With regard to the case of public investments in energy efficiency in the housing sector, the research provides a complex analysis of the factors affecting the impact of the renovation of housing sector on sustainable development of the country.

The practical significance of the doctoral thesis:

- The results and conclusions obtained in the research may be applied (even though to a limited extent) to other EU Member States (mostly CEE countries);
- the thesis contributes to the research on the increase of Lithuanian energy security (efficient consumption of energy resources and energy is one of the key long-term strategic goals of the Lithuanian energy sector);
- efficient consumption of energy resources and energy is one of the key long-term strategic goals of the Lithuanian energy sector;
- the developed evaluation model for energy efficiency investments in the housing sector allows for a regular evaluation of the progress and impact of the interventional state programme;
- the thesis provides an empirical justification to the impact of public energy efficiency investments in the housing sector on employment. This is the first attempt in Lithuania to evaluate the impact of investments of such type on employment;
- the developed research methodology for energy efficiency investments in the housing sector creates opportunities for further research which would be targeted at the improvement of energy efficiency evaluation and which has not been carried out to this day due to the complexity of the impact of the object under analysis and a complicated interpretation of the available statistical data.

Logical structure of the thesis. The goal of the doctoral thesis and the sequence of objectives reflect in the logical structure of the doctoral thesis comprising of four parts.

The first part is dedicated to the analysis of the concept of energy and its efficiency, as well as the key energy indicators. The thesis addresses the courses of energy policy, the relationship between energy supply, transformation and increase in efficiency, the global and Lithuanian tendencies of consumption of energy resources and summarises the aspects under analysis by specifying the role of the national economic policy and efficient energy consumption in the global environment. It presents the concept of housing and analyses the relationship between the housing sector, households and the final energy consumption. Special attention is paid to the analysis of the sector of the Lithuanian multi-apartment buildings and the consequences of the mass construction of residential multi-apartment buildings in cities by revealing the benefit of renovation (modernisation) of multi-apartment buildings.

The second part is aimed at the theoretical justification of the benefit of energy efficiency investments in the buildings to the state. It analyses the present-day scientific discussions on the state intervention in the energy efficiency market, specifically the sector of energy efficiency. The relationship between the national economic policy and the concept of sustainable development is analysed. The summary of the theoretical data leads to the presentation of the approach towards the relationship between the environmental, social and economic aspects and energy efficiency investments in the housing sector.

The third part analyses urban issues, by focusing on the topics of energy efficiency in housing. It discusses the development of the EU position in solving

urban issues, presents a new EU financial instrument designed to provide support for sustainable investments in cities, as well as to solve the problems of energy efficiency in the housing sector. The thesis provides an individual analysis of the investments in housing renovation measures applied in the EU Member States, as well as the energy efficiency programmes implemented at the EU level. Based on the theoretical analysis carried out in the second part of the thesis, the chapter ends with a qualitative evaluation of the programme of renovation of the housing sector implemented in Lithuania.

The fourth part grounds the logical scheme of the empirical research and the methods selected. It introduces the evaluation model for energy efficiency investments in the multi-apartment housing sector, carries out calculations and presents empirical research results.

REVIEW OF THE CONTENT OF DISSERTATION

The problem of the scarcity of resources and search for solutions for their effective use are presented as the most important aspects of society acting under conditions of a modern economy. Any economic and social activity requires energy resources; this is why the entire history of humankind is closely related with the use of energy. Theoretical consideration of this notion is complicated by the fact that in Lithuania, both in legal acts and scientific theoretical and research works, a multitude of versions of this term are used (Kveselis, 2008; Lepkova & Vilutienė, 2008; Jankauskas, 2008; Kveselis, 2008; Grigonienė, Kveselis, & Tamonis, 2004, Stankevičius, 2008; Buivis & Turauskas, 2004; Butvinskas, 2011, Kugelevičius & Kuprys, 2004).

After the analysis of a variety of notions related to energy efficiency the thesis reveals that energy efficiency means lower energy costs while maintaining economic activity and service at the same level. The significance of energy sector has been growing continuously as a result of threateningly growing energy demand, satisfaction of which is not always kept up by limited energy resources, as well as a result of highly increased concern about global climate warming. The doctoral thesis arrives at a conclusion that effective use of energy is one of the most important long-term goals of the national economic policy and also of energy policy as its component, as well as one of the most cost-effective ways to increase energy supply security and reduce emissions of greenhouse gases and other pollutants. From many aspects more effective energy consumption can be assessed as the major energy resource of the state (see Fig. 1).

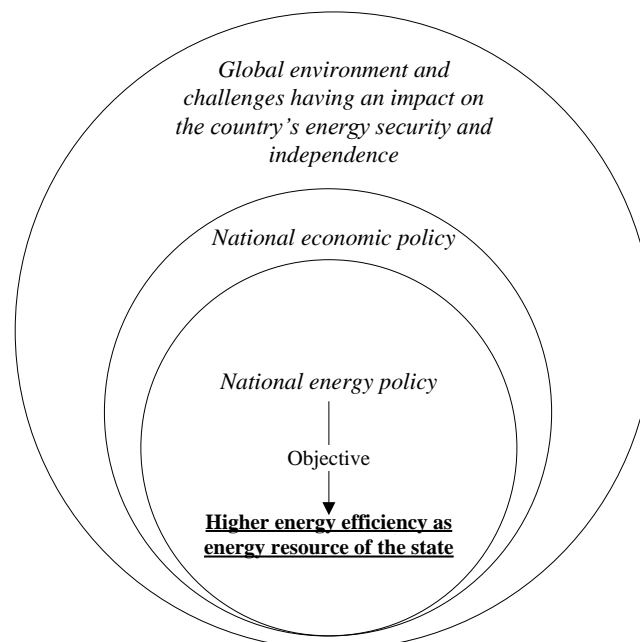


Fig. 1. Place of the national economic policy and effective consumption of energy in the global environment

On the basis of the analysis of the current Lithuanian energy sector, the thesis arrives at a conclusion that an especially great energy saving potential lies on the consumer side. For Lithuania, which has next to no low-cost primary energy resources of its own, rational, effective and prudent consumption of energy of different types at all links of the energy cycle is a permanent objective and priority. According to the data of the study of energy consumption in Lithuanian households, in 2009 around one third (more than 31%) of all final energy was consumed in housing possessed by households. Almost 12% of all energy was consumed by households for illumination and electric appliances and more than 7% – for cooking. Home heating and domestic hot water preparation account for the major part of all energy consumed in households, i.e. as much as 81% (Lithuanian Statistics, 2011). Therefore, measures for improvement of energy efficiency in the residential sector are closely related to the housing sector and, particularly, to multi-apartment buildings. Taking into account high energy costs in buildings, renovation and modernisation of residential buildings is one of the main goals established in the Lithuanian National Energy Strategy.

The thesis presents an analysis of the housing sector, which is associated with households and is related to final energy consumption. In order to assess the actual situation in the country's energy production, transformation and consumption sectors, it has been established that analysis of the share of final energy, which is consumed in households, in the country's fuel and energy balance is particularly important because households are among the greatest energy consumers in the major part of the world. When comparing the industry, agriculture, trade and service and household sectors in terms of final consumption of heating and electric power, the household sector consumes three times as much heating as the industry and trade sectors (Klevas, 2010). According to the data of the National Energy Strategy, the structure of final energy consumption is currently dominated by the household and transport sectors where more than 60% of energy supplied to the country's industries is consumed (the Government of the Republic of Lithuania, 2008).

When analysing the causes of the situation when a major part of energy in Lithuania and most other CEE countries is consumed for heating of residential housing, it has been discovered that it is directly related to the geographical location of the region in a colder climatic zone and the post-social energy crisis, which caused a problem inherent to the whole region – 'hidden' geography of energy poverty (Buzar, 2007). It should be also noted that the major part (60%) of multi-apartment buildings in the region and in Lithuania was constructed during the last four decades of the previous century and heat consumption for the heating of multi-apartment and other buildings depends on the condition of these buildings. If old multi-apartment buildings, which consume heat in a non-efficient manner, were renovated (modernised), heat consumption losses would decrease by around 50% and it would allow residents to save approximately LTL 680 million per year, while payments for heat would decrease to as low as ~ LTL 172/month for a 60 m² apartment (Lithuanian District Heating Association, 2011).

Taking into account the fact that economic policy is divided into two main groups, i.e. macroeconomic policy, which is aimed at improving the efficiency of distribution of resources and microeconomic policy, which is aimed at ensuring better

utilisation and price stability of resources, in the course of the consideration of the problematics of the renovation of residential housing, it has been established that policy objectives and policy measures of both groups are important. Microeconomic policy is important because it is associated with households, which form a constituent part of the circulation model of the economy, as well as with budget limitations and considers issues of the maximisation of welfare of households. In the meantime, macroeconomic policy is important in order to analyse the choice of appropriate measures with a view to investing in the housing renovation sector at the national level with regard to the objectives of justice and social equality (see Fig. 2).

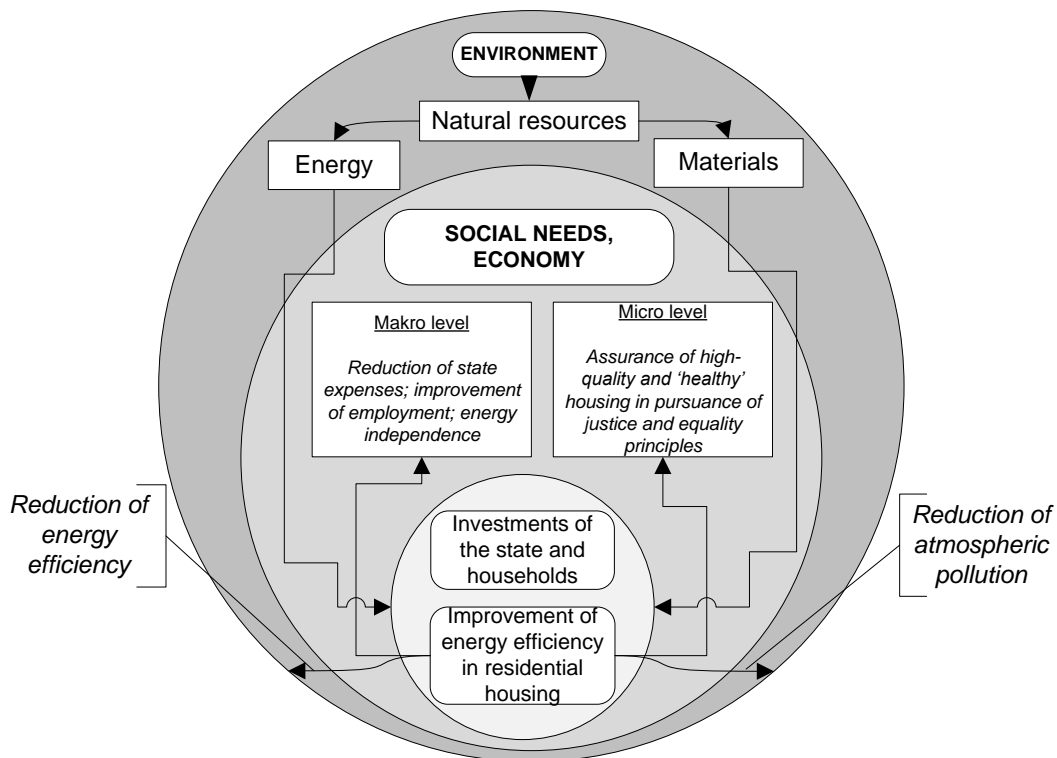


Fig. 2. Relationship of environmental, social and economic aspects with investments in the improvement of energy efficiency in housing on the basis of the idea of sustainable development

After restoration of Lithuania’s independence implementation of a new national investment policy and strategy was started, which is aimed at ensuring the country’s economic growth, increasing the state’s financing volumes and rational rearranging the investment financing structure in accordance with the most important sources of funding. Taking into account the fact that in the thesis effective energy consumption is attributed to the most important long-term goals of the national economic policy, the author emphasises that limited possibilities of the national budget prevent allocation of sufficient funds for the renovation of all residential housing in Lithuania in order to improve its energy efficiency. In this situation, one has to search for various financing sources, forms and implementation mechanisms for investments in the Lithuanian residential housing. The thesis has analysed both aspects of the financial system – the use of both the national budget and funds of households for the renovation of housing in order to improve its energy efficiency. It is concluded that

the main incentives for the improvement of energy efficiency include the objective of utilising, as effectively as possible, limited economic resources for economic entities and reducing expenses for energy consumption and thus increasing the purchasing power of households.

Issues of energy efficiency in the economic policy of a state are inseparable from the notion of welfare economics. In order to understand which national policy should promote energy efficiency, it is concluded that it is necessary to clearly understand and assess those market failures which may form the causes or pretext for the state to intervene in the housing renovation sector. State intervention may help to target certain market failures; however, the thesis holds a view that their presence is only a necessary condition for state intervention; however, not a sufficient one. It is also necessary to take into account the costs and possible inefficiency of such intervention. It is concluded in the thesis that in an ideal case, it would be sought by both the state and individuals to have such a scheme for state intervention in the energy efficiency improvement of the housing sector, which would not only establish whether or not to provide housing renovation as a public good and, if to provide, then its extent and choice of measures for targeting market failures but also to be able to define an effective method (in accordance with Pareto) for paying for that – i.e. such a plan of state investments and contributions of housing owners, which would improve the welfare of both.

The thesis has considered four main market failures related to the state intervention in the housing renovation sector: 1) public goods, 2) external effects, 3) incomplete markets and 4) imperfect/asymmetric information. It has been established and explained why the renovation of a multi-apartment building and related aspects can be attributable to impure public goods, i.e. a multi-apartment building is a commonly used good, the usefulness of which decreases due to the intensity of use or excessively high number of users and the use of the good is limited by space. During the implementation of a housing renovation project, households, i.e. residents of a multi-apartment building, are inseparably interconnected by consuming the same quantity of a public good. Besides, renovation of multi-apartment buildings is also emphasised as a process which will provide future benefits for both residents and the state and can be attributed to positive external effects. Multi-apartment buildings which ineffectively consume energy cause environmental pollution, which is a direct consequence of non-renovated residential buildings and provides one of the most striking examples of negative external effects.

The author arrives at a conclusion that as a result of imperfection of the market, lack of information and high initial investments, individual housing owners often fail to assess the benefit of housing renovation that manifests itself in long term. Taking into account this fact, national policies in most European and world countries provide for measurements and initiatives of obligatory or voluntary character in order to implement large-scale housing renovation. It should be noted that the established national housing renovation policy model or existing economic conditions may also cause a situation when renovation of housing places an additional financial burden on a resident and is just economically unreasonable. In this case, there may be a situation when renovation of housing is simply not implemented in the country. With regard to

this, the state may undertake the implementation of the project on a national scale in order to resolve the failure of individuals to assess benefits at a macroeconomic level.

So far, there is no consensus among Lithuanian scientists as to which term should be used when speaking about “tvari plėtra” or “darni plėtra” (both are translated into English as “sustainable development”). With provision of a comprehensive analysis of translation aspects and legal acts, it is proposed in the thesis to use the notion of “darni plėtra” on all occasions. The author arrives at a conclusion that sustainable development describes such development of a state which satisfies the needs of the current period while not endangering the satisfaction of the needs of future generations. It is emphasised that many of today’s energy supply and consumption systems are not sustainable in economic, environmental and social terms. The goal of the economic policy is to pursue an energy policy harmonised with the objectives of sustainable development and to incorporate energy efficiency into the country’s general policy, while coordinating actions of sectors and establishing and applying appropriate regulation. Energy efficiency is ensured when energy needs of the state economy sectors, which determine economic development and environmental protection as well as improvement of social conditions, are satisfied.

The thesis emphasises that the renovation of multi-apartment buildings and reduction of heat energy consumption in the housing sector is one of the priorities of the sustainable development of Lithuania and also contribution to public efforts in the mitigation of climate change. In the National Sustainable Development Strategy, the housing sector is associated with economic development and long-term and short-term goals as well as tasks for the implementation of the goals are established for its development. The doctoral thesis has assessed the implementation of the sustainable development principle in Lithuania when investing in energy efficiency improvement in the housing sector as well as prepares an assessment model, on the basis of which it is possible to assess an appropriate compromise between economic, environmental and social objectives.

The thesis analyses the importance of cities as the place of the implementation of many directions of the central EU policy, such as environmental protection, economic and social cohesion and growth, employment and innovations. It should be noted that it is urban areas where the relationship between environmental, economic and social aspects is mostly felt. Urban areas play an important role in the implementation of the strategic goals of the EU sustainable development. Cities is the place where most environmental problems arise; however, they are also an economic driving force and the place where a residential place for households is provided, commercial activities are carried out and most investments are made. The sector of urban buildings accounts for 40% of all energy consumed in the EU as well as for 36% of CO₂ emissions. The European sector of buildings is also an important factor for improvement of employment. In the thesis, the progress of the EU urban policy development is analysed in stages. During the EU programming period, urban policy was included in the main agenda for the EU cohesion policy, with simultaneous implementation of the JESSICA instrument intended for innovative urban development, which allows placing particular emphasis on energy efficiency measures including those for the sector of buildings.

Assessment of investments in energy efficiency improvement in the housing sector

The thesis has prepared a model for the assessment of investments in energy efficiency improvement in the sector of multi-apartment buildings and contains an empirical assessment of investments in energy efficiency improvement in the sector of multi-apartment buildings with provision of forecasts of financial, economic, social and environmental benefits as well as the analysis of the causes of those benefits on the basis of the prepared assessment model.

With a view to achieving the established objective, the study was divided into 3 separate parts:

1. Calculation of the amount of heat energy saved owing to the implementation of investments in energy efficiency improvement (the main indicator to be used in further parts of the study);
2. Assessment of the financial benefits from investments in energy efficiency improvement in multi-apartment buildings (assessment of the benefit at a household/micro level);
3. Assessment of investments in energy efficiency improvement in multi-apartment buildings from the aspect of sustainable development:
 - assessment of environmental condition indicators;
 - assessment of economic development indicators;
 - assessment of social development indicators.

Separate tasks of the study were set for achieving these objectives of the study, which are aimed at attaining the main goal of the doctoral thesis.

1. In order to calculate the amount of heat energy saved owing to the implementation of investments in energy efficiency improvement in multi-apartment buildings, one main task is set: to collect and analyse summary data on the implementation of the Renovation Programme with reference to the monitoring of the Renovation Programme carried out in 2007, 2008 and 2009. On the basis of the this indicator, both financial and sustainable development indicators are further calculated in the thesis.

2. In order to assess the financial benefits from investments in energy efficiency improvement in multi-apartment buildings, the following actions were performed:

1. Selection of the main financial calculation indicators on the basis of the analysis of the methods for the assessments of both general case investments and investments in energy efficiency improvement;
2. Identification of the main calculation scenarios with regard to the investment period, discount rate, provision of state support, increase of the value of an apartment in a multi-apartment building as a result of investments in energy efficiency improvement and average price of housing in a multi-apartment building;
3. Assessment of the financial benefits from investment projects for energy efficiency improvement in multi-apartment buildings.

When answering one of the main questions raised in the thesis, i.e. what is the impact of the national economic policy, which is aimed at achieving results in the energy efficiency market and, particularly, in the sector of the renovation of multi-apartment buildings, with regard to the social, economic and environmental aspects,

an assessment of the sustainable development indicators was performed. In order to achieve this objective, the following tasks were implemented:

1. Pursuant to the National Sustainable Development Strategy, the indicators, which are important in the consideration of investments in energy efficiency improvement in the housing sector and on the basis of which the conclusions of the study will be presented, have been selected;
2. Assessment of environmental condition indicators has been presented;
3. Assessment of economic development indicators has been presented;
4. Assessment of social development indicators has been presented.

The calculations based on the formed assessment model are aimed at studying causal relationships between various economic variables by the quantitative method and at providing statistically substantiated proofs in respect of those relationships. The formation of the model is useful from the following three aspects: 1) to improve understanding – the formed model helps to better understand relationships between different variables; 2) forecasting – the established causal relationships serve as the basis for the explanation of certain phenomenon and to provide a basis for the forecasting of future trends; 3) determination of alternatives – pursuant to different preconditions, models of this type allow creating an alternative reality, where it is possible to compare possible different situations and alternatives. Such modelling allows answering ‘what if’ questions (Brettell, 2003). It should be noted that models and statistical analysis of this type are not applied due to the lack of data or limited correspondence of the specification of the model with facts because of which the interpretation of the obtained results becomes especially complicated. This thesis is aimed at filling this gap.

When forming the model for the assessment of investments in energy efficiency improvement in the sector of multi-apartment buildings, it is sought to predict and define all variables which have an impact on the results being forecasted, to determine the relationships between the variables and to define the impact of those variables on the final dependent variable, i.e. general savings (they can be either positive or negative).

Methodology for the assessment of the impact on employment. Normally, the impact of investment programmes on employment may be divided into direct impact (impact on the sectors which directly participate in the programme), indirect impact (impact on a higher-level supply chain) and caused impact (the impact caused by the income available to households that has increased owing to the creation of new jobs and, in this case, energy savings). The impact of investment programmes on employment is usually assessed with the use of input-output analysis. Input-output tables allow analysing changes in the economic activities of all sectors which are related to the intervention either directly or indirectly. Taking into account the work intensity of each sector, it is possible to calculate the number of created and eliminated jobs as well as the net impact on employment. Besides, input-output analysis helps to calculate the caused impact by analysing the impact of the change in the final consumption by a household.

Fig. 3 provides the model, prepared by the author, for the assessment of investments in energy efficiency improvement in the sector of multi-apartment buildings in terms of sustainable development criteria. The input variables are

incorporated into a system directed to the preparation of a single final assessment in the economic, social and environmental aspect.

Table 1 provides an explanation of the indicators used in the assessment model.

Table 1. Explanation of the indicators used in the assessment model

Indicator	Explanation
MAB number	Total number of multi-apartment buildings
kDNS	Share of multi-apartment buildings to be renovated
M	Duration of the renovation programme
RN	Number of multi-apartment buildings to be renovated
MDN	Number of multi-apartment buildings that were involved in the monitorings of the renovation programme
MSE	Average amount of saved energy in accordance with the monitoring data of the renovation programme
MI	Average investment into renovation in accordance with the monitoring data
IA	Investment amount
ES	Energy saved
GDP	GDP growth in prices of that time, %
EP	Energy price
WH	Working hours per year in energy sector
EP	Produced energy
IOT	Input-output tables
B	Fuel and energy balance
WCE	Working capacity in respect of energy produced
WCP	Working capacity in respect of production in monetary terms
CAL	Calorific value of natural gas
AW	Atomic weight of natural gas
SS	Monetary funds saved because of the renovation programme
PS	Monetary funds lost because of the renovation programme
I/O	Leontiev method
P	Production
GD	Saved amount of natural gas

Empirical results of assessment of investments in energy efficiency improvement in the housing sector

Upon performance of a financial assessment of the renovation (modernisation) of multi-apartment buildings, the obtained results showed that the investment projects for the improvement of the energy efficiency of multi-apartment buildings are financially effective. The usual pay-out time is relatively short (depending on the scenario, up to 8.39 years), the price of the saved energy is lower than the price of heat energy, and the net current value and the average rate of return are positive. As a result of the performance of an study of sustainable development indicators, energy savings should reach 6,027.8 TJ, which corresponds to 27.3% of the amount of 22,080 TJ, i.e. of the amount of heat energy currently consumed in Lithuanian households.

Actual emission would decrease by 2.2% in 2030; therefore, investments in the renovation of multi-apartment buildings will have a considerable positive contribution to the reduction of CO₂ emissions. The amount of ultimate energy consumed in households should decrease by around 19%. Expenses of a household on heat energy per resident should decrease by up to LTL 321 per year and account

for 30% in the common expense category, and all expenses in the category should decrease by up to 90% of the previous level, i.e. LTL 1,075 per year; total savings of households should amount to LTL 385.6 million per year.

Investments in the renovation of multi-apartment buildings should make a considerable impact on the annual change of jobs in the sectors; also the biggest impact on the increase in the GDP should manifest itself during those years when renovation works are carried out, i.e. from 2012 to 2020; during later periods (2025 – 2030), expenses of households will grow; however, it is probable that savings in households will show themselves at the expense of the energy sector; therefore, no obvious impact on the economy will be clearly noticed.

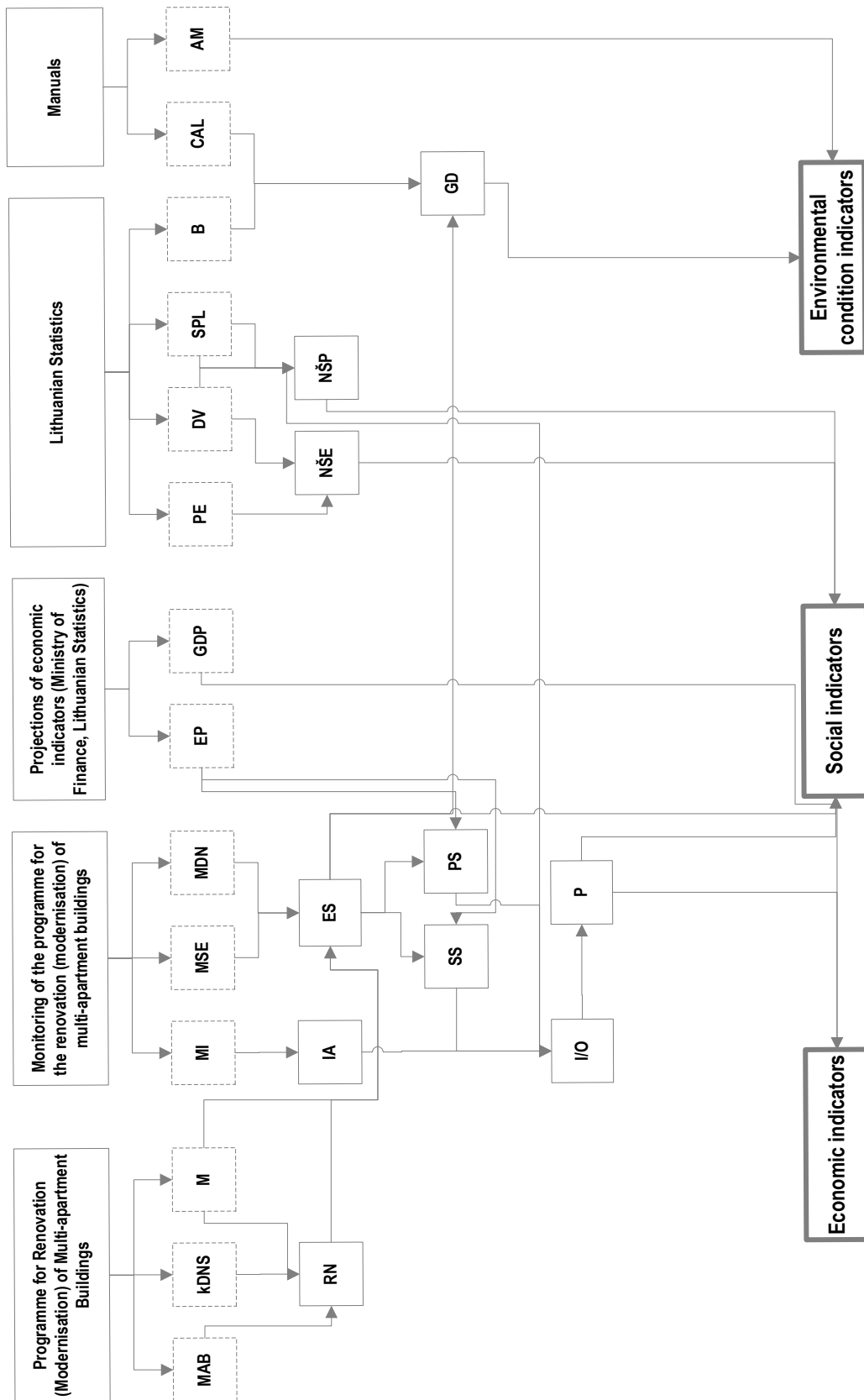


Fig. 3. Model for the assessment of investments in energy efficiency improvement in the sector of multi-apartment buildings

CONCLUSIONS

1. The problem of the scarcity of resources and search for solutions for their effective use are presented as the most important aspects of society acting under conditions of a modern economy. Effective use of energy is one of the most important long-term goals of the national economic policy and also of energy policy as its component, as well as one of the most cost-effective ways to increase energy supply security and reduce emissions of greenhouse gases and other pollutants. From many aspects more effective energy consumption can be assessed as the major energy resource of the state. For Lithuania, which has next to no low-cost primary energy resources of its own, rational, effective and prudent consumption of energy of different types at all links of the energy cycle is a permanent objective and priority.
2. It is established that measures for improvement of energy efficiency in the residential sector are closely related to the housing sector and, particularly, to multi-apartment buildings renovation of which is one of the main goals established in the Lithuanian National Energy Strategy. Housing sector is related to households which are one of the largest energy consumers throughout most of the world. It is concluded that the main incentives for the improvement of energy efficiency include the objective of utilising, as effectively as possible, limited economic resources for economic entities and reducing expenses for energy consumption and thus increasing the purchasing power of households.
3. Issues of energy efficiency in the economic policy of a state are inseparable from the notion of welfare economics. In order to understand which national policy should promote energy efficiency, it is concluded that it is necessary to clearly understand and assess those market failures which may form the causes or pretext for the state to intervene in the housing renovation sector. The thesis has considered four main market failures related to the state intervention in the housing renovation sector: 1) public goods, 2) external effects, 3) incomplete markets and 4) imperfect information. It has been established and explained why the renovation of a multi-apartment building and related aspects can be attributable to impure public goods, i.e. a multi-apartment building is a commonly used good, the usefulness of which decreases due to the intensity of use or excessively high number of users and the use of the good is limited by space. During the implementation of a housing renovation project, households, i.e. residents of a multi-apartment building, are inseparably interconnected by consuming the same quantity of a public good. Besides, renovation of multi-apartment buildings is also emphasised as a process which will provide future benefits for both residents and the state and can be attributed to positive external effects. Multi-apartment buildings which ineffectively consume energy cause environmental pollution, which is a direct consequence of non-renovated residential buildings and provides one of the most striking examples of negative external effects.
4. The thesis analyses the importance of cities as the place of the implementation of many directions of the central EU policy, such as environmental protection, economic and social cohesion and growth, employment and innovations. The

sector of urban buildings accounts for 40% of all energy consumed in the EU as well as for 36% of CO₂ emissions. The European sector of buildings is also an important factor for improvement of employment. In the thesis, the progress of the EU urban policy development is analysed in stages. During the EU programming period, urban policy was included in the main agenda for the EU cohesion policy, with simultaneous implementation of the JESSICA instrument intended for innovative urban development, which allows placing particular emphasis on energy efficiency measures including those for the sector of buildings.

5. Having summarised the implementation of the policies of the renovation of multi-apartment buildings in different Member States of the EU, it is concluded that support to the improvement of energy efficiency in the housing sector in the EU Member States is provided, most of all, in the form of grants, subsidised loans and tax incentives. Financial support is increasingly supplemented, or even replaced, with standards and rules applicable to the construction and renovation of buildings. Support also differs depending on the part of the country because regional and, sometimes, local authorities implement their own measures alongside with national ones. When a new programming period of the EU for 2007 – 2013 started and budget resources previously allocated for the renovation of the housing sector became exhausted, the Lithuanian National Energy Strategy set a task to use the funds of the EU Structural Funds for the renovation of multi-apartment buildings while improving their energy efficiency. That formed conditions for the establishment of a long-term operating fund for housing renovation.
6. In Lithuania, one of the most broadly used methods for the renovation of housing is applied, i.e. voting rather than a command mechanism. Irrespective of the fact that there are alternative mechanisms for the implementation of the renovation (modernisation) of multi-apartment buildings and that the selected model, probably, fails to promote large-scale nation-wide targeted housing renovation (because the current model is supported by independent initiative of single individuals), it is concluded that the financial model established in Lithuania is properly balanced, allows achieving considerable energy consumption savings, and is characterised by subsidy elements, i.e. provides benefits not only to the state, but also to an individual.
7. Upon performance of a financial assessment of the renovation (modernisation) of multi-apartment buildings, the obtained results showed that the investment projects for the improvement of the energy efficiency of multi-apartment buildings are financially effective not only when calculating the whole amount of investments but also when calculating only 85% of investments when owners of multi-apartment buildings are granted a 15% state subsidy. The usual pay-out time is relatively short (depending on the scenario, up to 8.39 years), the price of the saved energy is lower than the price of heat energy, and the net current value and the average rate of return are positive.
8. Energy efficiency is ensured when energy needs of the state economy sectors, which determine economic development and environmental protection as well as improvement of social conditions, are satisfied. The thesis emphasises that the

renovation of multi-apartment buildings and reduction of heat energy consumption in the housing sector is one of the priorities of the sustainable development of Lithuania and also contribution to public efforts in the mitigation of climate change. The doctoral thesis has assessed the implementation of the sustainable development principle in Lithuania when investing in energy efficiency improvement in the housing sector as well as prepares an assessment model, on the basis of which it is possible to assess an appropriate compromise between economic, environmental and social objectives.

9. As a result of the performance of an study of sustainable development indicators, further expected impact of the Programme for Renovation (Modernisation) of Multi-Apartment Buildings has been established: 1) energy savings should reach 6,027.8 TJ, which corresponds to 27.3% of the amount of 22,080 TJ, i.e. of the amount of heat energy currently consumed in Lithuanian households; 2) actual emission would decrease by 2.2% in 2030; therefore, investments in the renovation of multi-apartment buildings will have a considerable positive contribution to the reduction of CO₂ emissions; 4) the amount of ultimate energy consumed in households should decrease by around 19%; 5) expenses of a household on heat energy per resident should decrease by up to LTL 321 per year and account for 30% in the common expense category, and all expenses in the category should decrease by up to 90% of the previous level, i.e. LTL 1,075 per year; total savings of households should amount to LTL 385.6 million per year; 6) investments in the renovation of multi-apartment buildings will make a considerable impact on the annual change of jobs in the sectors; 7) the biggest impact on the increase in the GDP should manifest itself during those years when renovation works are carried out, i.e. from 2012 to 2020; during later periods (2025 – 2030), expenses of households will grow; however, it is probable that savings in households will show themselves at the expense of the energy sector; therefore, no obvious impact on the economy will be clearly noticed.

It should be noted that the obtained results should be interpreted with regard to the fact that it is difficult to predict the pace of the implementation of investments indented for the sector of renovation of multi-apartment buildings because the established financing instrument and the legal base for financing and implementation of renovation projects in Lithuania are still new in Lithuania and are constantly revised.

Guidelines and recommendations for further research:

The prepared methodology for the research of investments in the improvement of energy efficiency in the sector of multi-apartment buildings provides possibilities for further scientific research, which would be aimed at improving the assessment of programmes improving energy efficiency and which, so far, has not been performed because of the complicated nature of the impact of the object under analysis and sophisticated interpretation of available statistical data. In the meanwhile, the prepared model for the assessment of investments in energy efficiency improvement in the sector of multi-apartment buildings allows regularly assessing the progress and impact of the interventional national programme with regard to the programme being implemented in the country at that time. It is recommended to perform comprehensive analysis of models for the assessment of investments in energy

efficiency improvement in the sector of multi-apartment buildings to emphasizing their merits and demerits as well as to perform comparative analysis of the obtained data while selecting results of similar research obtained in other countries in order to improve the created model and enhance the reliability of the results to be obtained. Since it is very difficult to exactly assess the impact of programmes for the improvement of energy efficiency because of the lack of available statistical data, the assessment of the financial, economic, social, and environmental benefits received from the investments in energy efficiency improvement in the sector of multi-apartment buildings is based in this thesis only on statistical data and performed monitoring of the programme for the renovation of multi-apartment buildings, without applying additional survey of related sectors or other qualitative methods. It is recommended to expand research in this area by performing quantitative assessments of associated participants in this sector in order to look into the phenomenon under analysis and to explore additional benefits of the renovation (modernisation) of multi-apartment buildings.

APPROBATION AND DISSEMINATION OF THE RESEARCH RESULTS

Publications in reviewed scientific journals and reviewed conference proceedings of international conferences:

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7. Galinienė, B., & Bumelytė, J. (2008). Development of Real Estate Funds in Europe and Lithuania. *Ekonomika*, 83, 58-70.

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REZIUME

Temos aktualumas. Energija yra svarbi kiekvieno žmogaus kasdieniame gyvenime, o taip pat valstybiniu mastu, siekiant įgyvendinti energetinės politikos tikslus. Labiausiai paplitusi energijos rūšis yra šiluma. Didžiojoje pasaulio dalyje namų ūkiai yra vienas didžiausių energijos vartotojų ir didžioji dalis vartojimo, priklausomai nuo regiono, tenka būstui šildyti arba vėsinti. Energijos resursų vartojimas taip pat yra tiesiogiai susijęs su ekologinėmis problemomis, nes sąlygoja anglies dioksido (toliau – CO₂) išskyrimą į aplinką, o tai yra pagrindinės šiltnamio efektą sukeliančios dujos, dėl kurių vyksta globalinis klimato atšilimas. Šilumos vartojimo efektyvumo didinimas yra ypatingai svarbi kovos su klimato kaita priemonė, turinti ribotą poveikį energijos kainos didėjimui, taip pat įtakoja šalies energetinę priklausomybę nuo dujų importo. Šie iššūkiai ir galimybės sąlygoja tai, kad energijos efektyvumo didinimo būsto sektoriuje klausimas valstybės ekonominėje politikoje tampa svarbus siekiant konkurencingos ekonomikos ir darnaus vystymosi tikslų.

Didėjantis efektyvaus pastatų valdymo poreikis Europos miestuose labiausiai pastebimas naujų Europos Sąjungos (toliau – ES) valstybių narių regione, kur energijos vartojimo intensyvumas vis dar žymiai didesnis už senųjų ES valstybių narių. Vidurio ir Rytų Europos (toliau - VRE) šalys turi didžiulį potencialą didinti energijos vartojimo efektyvumą – daugumą šio regiono daugiabučių gyvenamųjų namų, pastatytų įgyvendinant masinę industrinę sovietinę namų statybą, reikia atnaujinti. Šio regiono gyvenamojo fondo būklei didelę įtaką turėjo perėjimo į rinkos ekonomiką procesas. Viena vertus, bendrojo ūkio raida paskatino būsto politikos pokyčius įvykdant sektoriaus restruktūrizavimą ir perduodant nuosavybės teises į būstą gyventojams. Kita vertus, patirtas ekonomikos nuosmukis, gyventojų pajamų mažėjimas bei didėjantis nedarbas dar labiau pablogino gyvenamojo būsto fondo, statyto pigių energijos išteklių laikais ir ilgą laiką tinkamai neprižiūrimo, būklę.

Šiame darbe pasirinkta nagrinėti energijos išteklių naudojimo Lietuvos gyvenamojo būsto sektoriuje atvejį. Efektyvus energijos išteklių ir energijos vartojimas yra vienas svarbiausių ilgalaikių Lietuvos energetikos strateginių tikslų, kadangi energijos taupymas yra neišvengiamas iššūkis tiek valstybei, tiek ir kiekvienam gyventojui. Nepaisant to, kad VRE valstybės pasirenka skirtingus ekonominius priemonių rinkinius siekiant energijos taupymo rezultatų bei būdus užtikrinti saugų ir sveiką būstą, Lietuvoje pastatams tenkantis energijos ir CO₂ emisijos suvartojimas atspindi valstybių grupės tendencijas, o būsto politikoje naudojamos priemonės – bendras regiono tendencijas. Darbe yra daroma prielaida, kad pagrindinės išvados yra taikytinos visoms VRE šalims, kurios įgyvendina ar planuoja įgyvendinti panašias su energijos efektyvumo būsto sektoriuje skatinimu susijusias iniciatyvas.

Lietuvoje apie 96 proc. daugiabučių namų yra pastatyti iki 1993 m. ir yra ekonomiškai ir energetiškai neefektyvūs. Iš jų apie 24,000 reikia atnaujinti (modernizuoti). Apskaičiuotas investicijų poreikis siekia 46 milijardus Lt. Dėl rinkos netobulumo, informacijos trūkumo bei reikalingų didelių pradinių investicijų pavieniai būsto savininkų sprendimai nesąlygoja veikslių masto ir poveikio valstybės

ekonominei politikai. Viešojo sektoriaus finansavimo skyrimas efektyviu energijos vartojimu grindžiamiems sprendimams pastatų sektoriuje ne tik padeda mažinti valdžios institucijų sąskaitas už energiją, tačiau ir efektyviau panaudoti iš gyventojų mokesčių pavidalu sukauptas lėšas. Didelių finansinių resursų valstybinio gyvenamojo būsto atnaujinimo įgyvendinimui yra reikalingos nacionalinio masto modernizaciją skatinančios programos.

XXI a. energijos efektyvumo klausimas tapo ne tik dominuojančiu Europos valstybinių ekonominių politikų diskurso objektu, bet ir patrauklia tema populistinėms politinėms aspiracijoms. Šiame darbe į energijos vartojimo efektyvumo aspektą bandoma pažvelgti kompleksiskai įvertinant teorinius ir praktinius su darbo objektu susijusius aspektus. Darbo pagrindą sudaro energijos vartojimo efektyvumo gyvenamojo būsto sektoriuje rinkos ydų, valstybės ekonominės politikos naudojamų priemonių bei poveikio valstybės ekonominei, socialinei ir aplinkosauginei raidai analizė. Ką ir kaip valstybė turėtų daryti norėdama efektyviai įgyvendinti būsto atnaujinimo didinant energetinį efektyvumą politiką, o taip pat kaip vertinti valstybės įgyvendinamą intervenciją būsto atnaujinimo sektoriuje yra svarbiausi šio darbo klausimai.

Darbas skirtas atskleisti gyvenamojo būsto atnaujinimo proceso kompleksiskumą ir sudėtingumą bei įvertinti investicijas į energijos efektyvumo priemones, susijusias su viešosios politikos veiksmais, kuriais siekiama paskatinti investavimo galimybes, o tuo pačiu poveikio ne tik socialinei ir ekonominei, bet ir aplinkos sritims. Kompleksinis minėtų trijų aspektų tyrimas yra susijęs su darnios plėtros koncepcija, kuri užėmė dominuojančią vietą pastarųjų kelių dešimtmečių pasaulinėje energetinio efektyvumo didinimo bei urbanistikos problematikoje ir yra plėtojama šiame darbe. Darbe remiamasi teorija, kad ekonomika, socialinės reikmės ir aplinka yra fiziškai susieti per medžiagų ir energijos apytaką.

Mokslinė problema. Nepaisant to, kad mokslinėje literatūroje egzistuoja nemažai energijos vartojimo efektyvumo būsto sektoriuje gvildenančių studijų, dauguma jų iki galo neatskleidžia valstybės lygmeniu priimamų sprendimų pasekmių socialiniam ir ekonominiam šalies vystymuisi, o taip pat jos tikrai epizodiškai bando paaiškinti viešųjų ir privačių investicijų į energijos efektyvumo didinimą būsto sektoriuje vietą gerovės ekonomikos teorijoje. Detali viešosios ekonominės politikos veiksnių analizė, o taip pat investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje finansinės, ekonominės, socialinės ir aplinkosauginės naudos vertinimo modelio bei metodikos sukūrimas prisidėtų prie energijos vartojimo efektyvumo tyrimo dalyko vystymo padėtų užpildyti tokio pobūdžio spragas mokslinėje literatūroje.

Darbo objektas - investicijos į energijos vartojimo efektyvumo didinimą daugiabučiuose namuose.

Darbo tikslas - išanalizuoti ir įvertinti viešosios ekonominės politikos veiksmus, kuriais siekiama rezultatų energijos vartojimo efektyvumo rinkose ir sukurti investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje finansinės, ekonominės, socialinės ir aplinkosauginės naudos vertinimo modelį.

Darbe keliami šie **uždaviniai**:

12. Atskleisti, kuo svarbios investicijos į energijos vartojimo efektyvumo didinimą valstybės ekonominės politikos kontekste.
13. Įvertinti energijos vartojimo efektyvumo svarbą būsto sektoriuje ir išanalizuoti namų ūkių energijos vartojimo ypatumus daugiabučiuose namuose.
14. Teoriškai pagrįsti investicijų į energijos vartojimo efektyvumo didinimą būsto sektoriuje naudą valstybei.
15. Pagrįsti valdžios intervenciją į energijos vartojimo efektyvumo rinką gerovės ekonomikos teorijos kontekste ir išanalizuoti rinkos ydas, susijusias su energijos vartojimo efektyvumo priemonėmis gyvenamojo būsto sektoriuje.
16. Išanalizuoti ir apibendrinti darnaus vystymosi koncepciją ekonomikos literatūroje ir jos sąsajas su energijos vartojimo efektyvumo didinimo priemonėmis gyvenamojo būsto sektoriuje.
17. Įvertinti miesto, kaip visuomeninio, ekonominio ir statybinio techninio organizmo bei būsto, kaip pagrindinės visuomenės buvimo vietos, tarpusavio sąsajas bei išanalizuoti šiuolaikinių ES miestų problemas ir darnaus vystymosi aspektus.
18. Išanalizuoti ES valstybėse narėse taikomas investicijų į energijos efektyvumo didinimo programas, o taip pat ES lygmeniu įgyvendinamas iniciatyvas.
19. Atlikti kokybinį Lietuvoje įgyvendinamos valstybinės daugiabučių namų atnaujinimo (modernizavimo) programos vertinimą.
20. Parengti investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje tyrimo metodologiją.
21. Parengti investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje vertinimo modelį.
22. Empiriškai įvertinti investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje ir pateikti finansinės, ekonominės, socialinės ir aplinkosauginės naudos prognozes.

Tyrimo metodai. Tyrimo pagrindas – kompleksinis požiūris į tyrimo objektą ir jo sudedamąsias dalis. Disertacijoje iškeliami tirti bei teoriniams ir praktiniams rezultatams gauti buvo naudojami bendrieji moksliniai ir specialūs tyrimo metodai: mokslinės literatūros analizė ir sisteminimas, lyginamoji analizė, antrinių šaltinių analizė, loginis modelis, kiti kokybiniai metodai, statistinių duomenų analizė, grupavimas, grafinis modeliavimas ir kt. Atskira grupė metodų buvo taikoma prognozuojant būsto atnaujinimo sektoriaus finansinę, ekonominę, socialinę ir aplinkosauginę naudą: 1) stebėsenos šaltinių analizė; ir 2) sąnaudų ir išėigos analizė (angl. *input-output analysis*), kuri leido analizuoti visų sektorių ekonominės veiklos pokyčius, kurie tiesiogiai ar netiesiogiai susiję su valstybinio sektoriaus intervencija. Atsižvelgiant į kiekvieno sektoriaus darbo intensyvumą, apskaičiuotas sukurtų ar panaikintų darbo vietų skaičius ir grynasis poveikis užimtumui. Taip pat sąnaudų ir išėigos analizė padėjo apskaičiuoti pokyčio namų ūkio galutiniame suvartojime poveikį. Statistiniam empiriniam tyrimo rezultatų apdorojimui naudotos MS Excel 2010 lentelės ir matematinio programavimo įrangos paketas MatLab 7.12.

Disertacijoje atlikta įvairios mokslinės, statistinės ir metodus nagrinėjančios literatūros analizė. Rengiant disertaciją daugiausia naudota Lietuvos ir kitų VRE šalių mokslinė literatūra. Pagrindiniai naudoti šaltiniai yra: moksliniai straipsniai, nagrinėjantys valstybės intervencijos būsto sektoriuje teorinius ir praktinius aspektus, empiriniai tyrimai, atspindintys naujausius energijos efektyvumo tyrimų rezultatus, teisės aktai, reglamentuojantys energijos vartojimo efektyvumo skatinimą ES ir būsto atnaujinimo politikos įgyvendinimą Lietuvoje, ES tyrimai apie energijos vartojimo efektyvumo priemonių įgyvendinimą ES valstybėse narėse, konferencijų medžiaga ir kiti šaltiniai nurodyti literatūros sąrašė.

Tyrimo apribojimai. Pripažįstama, kad labai sudėtinga tiksliai įvertinti energijos vartojimo efektyvumą didinančių programų poveikį dėl prieinamų statistinių duomenų stygiaus. Darbe investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje finansinės, ekonominės, socialinės ir aplinkosauginės naudos vertinimas yra paremtas tikrai istoriniais statistiniais duomenimis ir atliktais daugiabučių namų atnaujinimo programos monitoringais, neatliekant papildomų susijusių sektorių apklausos ar kitų kokybinių metodų, kurie galimai leistų išsamiau pažvelgti į nagrinėjamą reiškinį ir atskleisti papildomą naudą. Be to sunku prognozuoti investicijų, skirtų daugiabučių namų atnaujinimo sektoriuje įgyvendinimo tempą, kadangi sukurtas finansinis instrumentas ir atnaujinimo projektų finansavimo ir įgyvendinimo teisinis pagrindas yra vis dar nauji Lietuvoje ir nuolat peržiūrimi. Todėl pateiktas empirinis naudos įvertinimas ir gauti rezultatai turėtų būti interpretuojami suprantant įvardintas rizikas.

Mokslinis naujumas: teorinė ir praktinė reikšmė. Šiame darbe investicijos į energijos vartojimo efektyvumo didinimą būsto sektoriuje yra nagrinėjamos ne vien tikrai pritaikymo aspektais, tačiau atskleistos ir pagrįstos valstybės intervencijos į energijos vartojimo efektyvumo sektorių teorinės prielaidos.

Darbas yra susijęs su teorinių prielaidų valstybės intervencijos į energijos vartojimo efektyvumo sektorių, ir konkrečiai, didinant energijos efektyvumą būsto sektoriuje, analize. Iki šiol Lietuvoje valstybės intervencijos instrumentai į būsto sektorių buvo nagrinėjami tikrai jų kūrimo ir pritaikymo aspektais, tačiau teorinis valstybinės būsto atnaujinimo politikos įvertinimas nebuvo nagrinėjamas (arba nagrinėjami pavieniai aspektai). Darbe yra pateiktas nuoseklus ir sistemingas viešosios politikos ekonominių sprendimų energijos vartojimo efektyvumo didinimo srityje būsto sektoriuje nagrinėjimas, atskleidžiant visapusišką poveikį valstybės ekonominiam, socialiniam ir aplinkosauginiam vystymuisi. Iki šiol buvo tik pavieniai bandymai tirti būsto sektoriaus atnaujinimo programų socialinį, ekonominį ir aplinkosauginį poveikį tam tikrais laikotarpiais arba nagrinėjant atskirus energijos vartojimo efektyvumo didinimo aspektus.

Disertacijoje ištirtas naujas būsto sektoriaus atnaujinimo finansavimo mechanizmas (paremtas atsinaujinančio finansinio fondo logika), skirtingai nuo daugumos mokslinių tyrimų Lietuvoje, kurie apsiriboja valstybinės būsto politikos, paremtos subsidijų teikimo logika, nagrinėjimu. Taip pat mokslinio tyrimo metu, remiantis viešųjų investicijų į energijos vartojimo efektyvumą būsto sektoriuje atveju, pateikiama kompleksinė veiksnių, įtakančių būsto sektoriaus atnaujinimo poveikį darniam valstybės vystymuisi, analizė

Praktinė darbo reikšmė:

- mokslinio tyrimo metu gauti rezultatai ir išvados gali būti taikomos (nors ir ribotai) kitoms ES valstybėms narėms (labiausiai VRE šalims);
- darbas prisideda prie Lietuvos energetinio saugumo didinimo tyrimų (efektyvus energijos išteklių ir energijos vartojimas yra vienas svarbiausių ilgalaikių Lietuvos energetikos strateginių tikslų);
- parengtas investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje vertinimo modelis leidžia reguliariai vertinti intervencinės valstybės programos eigą ir poveikį;
- empiriškai pagrįstas viešųjų investicijų į energijos vartojimo efektyvumą būsto sektoriuje poveikis užimtumui. Iki šiol Lietuvoje nebuvo bandymų įvertinti tokio pobūdžio investicijų poveikio užimtumui;
- parengta investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje tyrimo metodika sudaro galimybes tolimesniems moksliniams tyrimams, kuriais būtų siekiama tobulinti energijos vartojimo efektyvumo vertinimus ir kurie iki šiol nebuvo atliekami dėl nagrinėjamo objekto poveikio kompleksiskumo ir sudėtingo prieinamų statistinių duomenų interpretavimo.

Loginė darbo struktūra. Disertacijos darbo tikslas ir uždavinių seka atsispindi disertacijos loginėje struktūroje, kurią sudaro keturios darbo dalys.

Pirma dalis skirta energijos ir jos vartojimo efektyvumo sampratos ir pagrindinių energetinių rodiklių analizei. Analizuojamos energetinės politikos kryptys, energijos tiekimo, transformavimo ir vartojimo efektyvumo didinimo ryšys, pasaulinės ir Lietuvos energijos išteklių vartojimo tendencijos, o taip pat pateikiamas analizuojamų aspektų apibendrinimas nusakant valstybės ekonominės politikos ir efektyvaus energijos vartojimo vietą globalioje aplinkoje. Pateikiama būsto samprata, o taip pat analizuojamos būsto sektorius sąsajos su namų ūkiais ir galutiniu energijos vartojimu. Atskiras dėmesys skiriamas Lietuvos daugiabučių namų sektoriaus analizei ir masinės gyvenamųjų daugiabučių namų statybos pasekmėms miestuose, atskleidžiant daugiabučių namų atnaujinimo (modernizavimo) naudą.

Antra dalis yra skirta investicijų į energijos vartojimo efektyvumo didinimą būsto sektoriuje naudos valstybei teoriniam pagrindimui. Analizuojamos dabartinės mokslinės diskusijos dėl valstybės intervencijos į energijos vartojimo efektyvumą, konkrečiai, energijos vartojimo efektyvumo sektoriaus rinką. Nagrinėjamas ryšys tarp valstybinės ekonominės politikos ir to, kas suprantama kaip darnus vystymasis. Apibendrinus teorinę medžiagą, pateikiamas požiūris į aplinkosauginio, socialinio ir ekonominio aspektų ir investicijų į energinio efektyvumo didinimą būste sąryšingumas.

Trečioje dalyje analizuojama miestų problematika, ypatingą dėmesį skiriant energijos vartojimo efektyvumo pastatuose klausimams. Nagrinėjama kaip vystėsi ES požiūris sprendžiant miestų klausimus, pristatomas naujas ES finansinis instrumentas, skirtas teikti paramą darnioms investicijoms miestuose, o taip pat energijos vartojimo efektyvumo gyvenamojo būsto sektoriuje problemoms spręsti. Atskirai nagrinėjamos ES valstybėse narėse taikomas investicijų į būsto atnaujinimo priemonės, o taip pat ES lygmeniu įgyvendinamos energijos vartojimo efektyvumo didinimui skirtos programos. Remiantis antroje darbo dalyje atlikta teorine analize, skyriaus pabaigoje

pateikiamas kokybinis Lietuvoje įgyvendinamos būsto sektoriaus atnaujinimo programos vertinimas.

Ketvirtoje dalyje pagrindžiama empirinio tyrimo loginė schema ir pasirinkti metodai. Parengiamas investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje vertinimo modelis, atliekami skaičiavimai ir pateikiami empiriniai tyrimo rezultatai.

Disertacijos tyrimo rezultatų realizavimas. Mokslo tyrimo rezultatai paskelbti straipsniuose, kurie publikuoti daktaro disertacijai pripažįstamuose mokslo leidiniuose ir skaityti moksliniai pranešimai disertacijos tematika tarptautinėse konferencijose.

IŠVADOS

1. Išteklių ribotumo problema ir efektyvaus jų vartojimo sprendimų paieškos yra svarbiausi visuomenės, veikiančios modernios ekonomikos sąlygomis, aspektai. Efektyvus energijos vartojimas yra vienas svarbiausių ilgalaikių valstybės ekonominės, kartu ir energetinės politikos, kaip sudedamosios dalies, tikslų, o taip pat vienas iš rentabiliausių būdų didinti energijos tiekimo saugumą ir mažinti šiltnamio efektą sukeliančių dujų ir kitų teršalų išmetimą. Daugeliu aspektų efektyvesnis energijos vartojimas gali būti vertinamas kaip didžiausias valstybės energijos išteklius. Lietuvai, beveik neturinčiai savų pigių pirminių energijos išteklių, racionalus, efektyvus ir taupus įvairių rūšių energijos vartojimas visose energetinio ciklo grandyse yra nuolatinis tikslas ir prioritetas.
2. Nustatyta, kad energijos vartojimo efektyvumo didinimo priemonės gyvenamajame sektoriuje yra tarpiai susijusios būsto, ir konkrečiai, daugiabučių namų sektoriumi, kurio atnaujinimas yra vienas pagrindinių Lietuvos nacionalinės energetikos strategijos tikslų. Būsto sektorius yra siejamas su namų ūkiais, kurie yra vienas didžiausių energijos vartotojų didžiojoje pasaulio dalyje. Darbe daroma išvada, kad pagrindinės paskatos ūkio subjektams didinti energijos vartojimo efektyvumą yra siekimas kuo geriau panaudoti ribotus ekonominius išteklius, o namų ūkiams - mažinti išlaidas energijos vartojimui ir taip didinti savo perkamąją galią.
3. Siekiant suprasti, kokia valstybės politika turėtų skatinti energijos vartojimo efektyvumą, daroma išvada, kad reikia aiškiai suprasti ir įvertinti būtent tas rinkos ydas, kurios gali būti priežastis ar pretekstas įsikišti valstybei į būsto atnaujinimo sektorių. Darbe išnagrinėtos keturios pagrindinės rinkos ydos, susijusios su valstybės įsikišimu į būsto atnaujinimo sektorių: 1) viešosios gėrybės, 2) išorinės pasekmės, 3) netobulos konkurencijos rinkos ir 4) asimetrinė informacija. Nustatyta ir paaiškinta, kodėl daugiabučio namo atnaujinimas ir su juo susiję aspektai gali būti priskirtinas negrynosioms viešosioms gėrybėms, t.y. daugiabutis namas yra bendrai naudojama gėrybė, kurios naudingumas mažėja dėl naudojimo intensyvumo, ar per didelio naudotojų skaičiaus, o taip pat gėrybės vartojimas yra apribotas erdve. Būsto atnaujinimo projekto įgyvendinimo metu namų ūkiai, t.y. daugiabučio namo gyventojai, yra neatsiejamai susiję vartodami vienodą viešosios gėrybės kiekį. Taip pat daugiabučių namų atnaujinimas akcentuojamas kaip procesas, kuris duoda naudos tiek gyventojams, tiek valstybei ateityje ir gali būti priskiriamas prie teigiamų išorinių efektų. Neefektyvūs energiniu požiūriu daugiabučiai namai sąlygoja aplinkos taršą, kuri yra tiesioginė neatnaujintų gyvenamųjų namų pasekmė, yra vienas ryškiausių neigiamų išorinių efektų pavyzdžių. Dėl rinkos netobulumo, informacijos trūkumo bei didelių pradinių investicijų pavieniai būsto savininkai dažnai nesugeba įvertinti ilgajame laikotarpyje pasireiškiančios būsto atnaujinimo naudos. Atsižvelgiant į tai, daugumoje Europos ir pasaulio šalių valstybinė politika numato prievartinio arba laisvo pobūdžio priemones ir iniciatyvas, siekiant įgyvendinti masinį būsto atnaujinimą.
4. Darbe išanalizuota miestų, kaip centrinės daugelio ES politikos įgyvendinimo krypčių, tokių kaip aplinkosauga, ekonominės ir socialinės sanglauda bei augimas, užimtumas bei naujovių įgyvendinimo vieta, svarba. Miestų pastatų

sektoriui tenka 40 proc. visos ES suvartojamos, o taip pat 36 proc. CO₂ emisijų. Europos pastatų sektorius taip pat yra svarbus užimtumo didinimo veiksnys. Darbe ES miestų politikos vystymosi raida išanalizuota etapais. 2007-2013 m. ES programavimo periode miestų politika buvo įtraukta į pagrindinę ES sanglaudos politikos darbotvarkę, kartu įgyvendinant inovatyvų miestų plėtrai skirtą instrumentą JESSICA, kuris leidžia skirti ypatingą dėmesį energijos vartojimo efektyvumo priemonėms įskaitant ir pastatų sektoriui.

5. Apibendrinus daugiabučių namų atnaujinimo politikų įgyvendinimą skirtingose ES šalyse, daroma išvada, kad parama energijos vartojimo efektyvumo didinimui būsto sektoriuje ES valstybėse narėse daugiausiai teikiama dotacijų, subsidijuojamų paskolų ir mokesčių lengvatų forma. Finansinę paramą vis dažniau papildo, ar net pakeičia, pastatų statybai ir atnaujinimui bei būsto pardavimui ir nuomai taikomi standartai ir taisyklės. Parama taip pat skiriasi priklausomai nuo šalies dalies, nes regioninės, o, kartais, vietos valdžios institucijos kartu su nacionalinėmis priemonėmis įgyvendina ir savo sukurtas priemones. Prasidėjus naujam ES 2007 – 2013 m. programavimo periodui bei pasibaigus prieš tai būsto sektoriaus atnaujinimui skirtiems biudžeto ištekliams, Lietuvos nacionalinėje energetikos strategijoje buvo įtvirtintas uždavinys panaudoti ES struktūrinių fondų lėšas daugiabučiams namams atnaujinti, didinant jų energetinį efektyvumą. Tai sudarė sąlygas įkurti ilgalaikį apyvartinį būsto atnaujinimo finansavimo fondą.
6. Lietuvoje yra taikomas vienas iš plačiausiai naudojamų sprendimo dėl būsto atnaujinimo būdas, t.y. balsavimas, o ne komandinis mechanizmas. Nepaisant to, kad egzistuoja alternatyvūs daugiabučių namų atnaujinimo (modernizavimo) įgyvendinimo mechanizmai, ir kad pasirinktas modelis, tikėtina, neskatina masinio valstybės mastu siektino įgyvendinti būsto atnaujinimo (kadangi dabartinis modelis yra paremta pavienių gyventojų savarankiška iniciatyva), daroma išvada, kad Lietuvoje sukurtas finansinis modelis yra tinkamai subalansuotas, leidžia pasiekti žymius energijos vartojimo sutaupymus, o taip pat pasižymi subsidiniais elementais, t.y. teikia naudą ne tikai valstybei, bet ir gyventojui.
7. Atlikus finansinį daugiabučių namų atnaujinimo (modernizavimo) vertinimą, gauti rezultatai parodė, kad daugiabučių namų energijos vartojimo efektyvumo investiciniai projektai yra finansiškai veiksmingi tiek skaičiuojant visą investicijų sumą ir skaičiuojant tik 85 proc. investicijų, kai daugiabučių namų savininkams teikiama 15 proc. valstybės subsidija. Paprastasis atsipirkimo laikas yra gana trumpas (priklausomai nuo scenarijaus – iki 8,39 metų), sutaupytos energijos kaina yra mažesnė už šilumos energijos kainą, o grynoji dabartinė vertė ir vidinė gražos norma yra teigiamos.
8. Energijos vartojimo efektyvumas užtikrinamas tuomet, kai patenkinami valstybės ūkio sektorių energijos poreikiai, nuo kurių priklauso ekonominė plėtra ir aplinkosauga, o taip pat gerinamos socialinės sąlygos. Nustatyta, kad daugiabučių namų atnaujinimas ir šiluminės energijos sąnaudų būsto sektoriuje mažinimas – vienas iš Lietuvos darnaus vystymosi prioritetų ir be kita ko, prisideda prie visuotinių pastangų švelninti klimato kaitą. Disertacijos įvertinta kaip Lietuvoje, įgyvendinant investicijas į energijos vartojimo didinimą būsto sektoriuje, yra

įgyvendinamas darnaus vystymosi principas, o taip pat parengtas vertinimo modelis, kuriuo remiantis galima įvertinti tinkamą kompromisą tarp ekonominių, aplinkosauginių ir socialinių tikslų.

9. Atlikus darnaus vystymosi rodiklių tyrimą, nustatytas tolimesnis tikėtinas Daugiabučių namų atnaujinimo (modernizavimo) programos poveikis: 1) energijos sutaupymai turėtų siekti 6.027,8 TJ, o tai sudaro 27,3 proc. nuo 22.080 TJ, t.y. dabar Lietuvoje namų ūkiuose sunaudojamos šilumos energijos; 2) faktinė emisija sumažėtų iki 2,2 proc. 2030 m., todėl investicijos į daugiabučių namų atnaujinimą padarys ženklią teigiamą įtaką CO₂ emisijos mažinimui; 4) galutinės energijos kiekis, sunaudotas namų ūkiuose turėtų mažėti apie 19 proc.; 5) namų ūkio išlaidos šilumos energijai vienam gyventojui turėtų mažėti iki 321 Lt per metus ir sudaryti 30 proc. nuo bendrų išlaidų kategorijoje, o visos išlaidos kategorijoje turėtų mažėti iki 90 proc. buvusio lygio, t.y. 1075 Lt per metus; suminiai namų ūkių sutaupymai turėtų sudaryti 385,6 mln. Lt per metus; 6) investicijos į daugiabučių namų atnaujinimą padarys ženklią įtaką metiniam darbo vietų skaičiaus pokyčiui sektoriuose; ir 7) didžiausia įtaka BVP augimui turėtų pasireikšti tais metais, kuriais būtų vykdomi atnaujinimo darbai, t.y. nuo 2012 m. iki 2020 m.; vėlesniuose laikotarpiuose (2025 – 2030 m.) didės namų ūkių išlaidos, bet sutaupymai namų ūkiuose, tikėtina, pasireikš energetikos ūkio sąskaita, todėl akivaizdus poveikis ekonomikai nebus aiškiai pastebimas.

Pažymėtina, kad gauti rezultatai turėtų būti interpretuojami atsižvelgiant į tai, kad yra sunku prognozuoti investicijų, skirtų daugiabučių namų atnaujinimo sektoriuje įgyvendinimui, tempą, kadangi sukurtas finansinis instrumentas ir atnaujinimo projektų finansavimo ir įgyvendinimo teisinis pagrindas yra vis dar nauji Lietuvoje ir nuolat peržiūrimi.

Tolimesnių tyrimų kryptys ir rekomendacijos.

Parengta investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje tyrimo metodika sudaro galimybes tolimesniems moksliniams tyrimams, kuriais būtų siekiama tobulinti energijos vartojimo efektyvumo didinančių programų vertinimą ir kurie iki šiol nebuvo atliekami dėl nagrinėjamo objekto poveikio kompleksiskumo ir sudėtingo prieinamų statistinių duomenų interpretavimo. Tuo tarpu parengtas investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje vertinimo modelis leidžia reguliariai vertinti intervencinės valstybės programos eigą ir poveikį, atsižvelgiant į tuo metu šalyje įgyvendinimą programą. Rekomenduojama atlikti išsamią kitų naudojamų investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje vertinimo modelių analizę, išryškinant jų privalumus ir trūkumus, o taip pat atlikti lyginamąją gautų duomenų analizę, parenkant kitose šalyse gautus panašių tyrimų rezultatus, siekiant tobulinti sukurtą modelį ir didinant gautinų rezultatų patikimumą. Kadangi labai sudėtinga tiksliai įvertinti energijos vartojimo efektyvumą didinančių programų poveikį dėl prieinamų statistinių duomenų stygiaus, darbe investicijų į energijos vartojimo efektyvumo didinimą daugiabučių namų sektoriuje finansinės, ekonominės, socialinės ir aplinkosauginės naudos vertinimas yra paremtas tikrai istoriniais statistiniais duomenimis ir atliktais daugiabučių namų atnaujinimo programos monitoringais, neatliekant papildomų susijusių sektorių apklausos ar kitų kokybinių metodų. Rekomenduojama plėsti šios srities tyrimus, atliekant kokybinius

susijusių sektoriaus dalyvių vertinimus, siekiant išsamiau pažvelgti į nagrinėjamą reiškinį ir atskleisti papildomą daugiabučių namų atnaujinimo (modernizavimo) naudą.

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