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Abstract. The paper presents a position of the authors on the current setup of the multi-apartment renovation process in Lithuania. The conducted investigation includes the actual case study analysis of the group of residential buildings in Birštonas. The paper deals with three areas that have a major impact on the success of the overall renovation process. The areas include the currently applied mechanisms for identifying and evaluating energy efficiency measures, data analysis of measuring actual energy efficiency and determination of the economic feasibility of the renovation process. Research results clearly indicate that the current shape of the program scheme is far from completion. The paper produces recommendations and research findings that could be used for further improvement on the process.

Keywords: building renovation, efficient energy use, energy audits, certificates of building energy performance.

1. Introduction and Problem Identification

In 2009, the final heat consumption in Lithuania reached 10295.8 GWh. Heat consumption stimulated by households correspondingly was 6014.5 GWh. In the country, the building sector accounts for 58 percent of the total heat consumption (Statistics Lithuania 2010). In the European Union, this index reaches 40 percent (Directive 2010/31/EU 2010). It is estimated that energy saving potential for installing energy efficiency measures in Lithuanian building sector accounts for 2900 GWh or 38 percent of the total consumed energy in the sector.

In 2004, the Government of the Republic of Lithuania passed (updated in 2008) the housing renovation programme providing that by 2020 70 percent of multi-apartment buildings built before 1993 will have been renovated (Government of the Republic of Lithuania 2009). The main target is to increase energy efficiency by not less than 30 percent in the renovated buildings. In order to achieve the target up to 2020, about 24000 of multi-apartment buildings have to undergo renovation. Yet, only 760 buildings have been renovated so far starting from 2004. In the majority of cases, a limited number of saving measures was installed. Renovation was practically ceased due to the lack of resources. In 2009, a new promotion mechanism was introduced. Following a new financial model, support for housing renovation projects at the State level is supplied by covering the costs of project preparation, 15 percent of expenditures on installing energy efficiency measures and granting the building owners with preferential credits of fixed 3 percent annual interest rate. It also provides support for low-income families by covering credit insurance and compensating preferential credit and annual interests.

It should be indicated that following Directive 2010/31/EC (2010) on the energy performance of buildings, starting from 2020, all new buildings shall have to meet minimum energy performance requirements maintaining or introducing more stringent measures than those currently valid in technical regulations. These principles shall also have to be adopted by Lithuania. Yet in our country, nearly zero-energy buildings are constructed in the individual housing market and there are few or almost no already existing model projects, especially those using renewable sources.

At the State level, housing renovation is definitely an evidential and targeted objective. From the State and business points of view, the attractiveness of renovation may be grounded on many factors such as State energy consumption balance, income correction, direct fuel saving effect and stimulated local economy. It also shall result in creating new jobs, a larger number of taxpayers etc. The benefit of renovation is substantiated in a few scientific fields of work analysing the technical and economic aspects of the process (Rogoža *et al.* 2008; Biekša *et al.* 2010; Zavadskas *et al.* 2008; González 2011).

The prepared monitoring report of housing renovation projects states that after the qualitative complex renovation of a building, a reduction in energy consumption may reach 50 percent (Kompetenciju centras 2009). Despite the new support mechanism, ambitious renovation plans are likely to be revised in the nearest future since the actual implementation of those is physically hardly possible. In order to explain the actual reasons, the existing specific conditions in Lithuania shall be reviewed hereinafter.

Despite the valuable experience of European countries in housing renovation, Lithuania failed to apply it directly. Distinctly from other European countries, in Lithuania, almost all flats were privatised and each flat owner automatically became a co-owner (a part-owner) of the building. It has become difficult to find consensus about renovation since only the general approval of building co-owners may launch the process. To sum up, the main reasons for a slow renovation process are as follows:

- most of the flats are privately owned and no condominiums (or other self-management forms) of flat owners are established; after privatisation, it took a while to establish the maintenance system and legal framework of the buildings;
- there is no consistent and long-term State approach to the building sector, its renovation and stimulation. A frequent change in support schemes diminishes the process and increases the risk of adverse changes in regulations in the future;
- the technical maintenance of buildings was unqualified. No practice was formed to accumulate funds for maintenance and inevitable renovation in the future.
- the State policy on energy efficiency is inactive and unstable, negative experience of a small part of residents, based on few cases, resulted in negative public attitude towards renovation;
- lack of qualified professionals. Until 2009, there were no qualification requirements to perform energy audit of a building, auditing preparation forms and techniques were vague;
- heating costs of the majority of flat owners have already corresponded to the substantial part of their revenue and additional liabilities are viewed as threat.

In the last decade, public buildings owned by the State have been very rapidly renovated and the EU funds have been widely used in various sectors. These projects and their results are reviewed in the following sources (Eksergija 2000; Government of the Republic of Lithuania 2008). Still, there is no proper monitoring of the results achieved in this sector.

The main objective of this article is to identify the problems of the housing renovation programme and to offer possible solutions and stimulation measures. The paper focuses on the decisions of the building owner to launch the renovation project and reviews evaluation aspects and problems of the technical and economic feasibility of renovation.

The authors of this paper are participating in 7th Framework Programme research project “Sustainable Zero Carbon ECO-Town Developments Improving Quality of Life across EU – ECO-Life” (see http://www.ecolife-project.eu/). The aim of the “ECO-Life project” is to demonstrate innovative integrated energy concepts throughout three countries in the EU where urban areas will be transformed into CO_2-neutral communities. The three communities in the project are: Høje Taastrup in Denmark, Kortrijk in Belgium and Birštonas in Lithuania. This publication reflects the author’s views and not necessarily those of the EC. The information in this document is provided as is and no guarantee or warranty is given that the information is fit for any particular purpose. The user thereof uses the information at its sole risk and liability. The *Community* is not liable for any use that may be made of the information contained herein.

2. Method for Identifying Energy Efficiency Measures

The co-owners’ decision to launch the building renovation process is determined by the available information and offered guarantees that the presented data are correct and estimated results shall be achieved. Logically thinking, if building‘s owner would have a detailed information and its comprehensive presentation, sufficient guarantees from the information supplier that the result will be achieved (heat savings), then the decision to start the modernisation would meet much less of resistance. Currently, economic feasibility is the main criterion on the basis of which implementation one or another modernisation measure is selected (the amount of investments and payback period).

Let us analyse the housing renovation process focusing on the stage of owners’ decision making. According to the existing renovation programme, if a building‘s owner expresses his/her wish to receive information on renovation possibilities, an investment project is prepared for a particular building. It consists of building inspection tables showing the analysis of the existing situation. Heat demand under standard conditions is determined by the energy performance certificate (the existing situation is evaluated). Furthermore, the planned heat savings are defined by the results of the energy performance certificate (prepared following CTR 2.01.09:2005) after the implementation of energy saving measures.

While reviewing the evolution of housing renovation attractiveness in Lithuania, it should be admitted that starting from its creation, structure and depth reduced gradually in the cause of time. The created and applied methods for the technical-energy evaluation of the building (technical-energy audits), which, according to the authors, were sufficiently detailed and served as the essential tool for the selection and substantiation of renovation measures, were considered to be surplus and removed from process documentation. They were replaced by the above mentioned simplified evaluations that directly used data received after the energy performance certification of the building.

It should be mentioned that while preparing energy performance certification, theoretic calculations are performed using a standard evaluation method focusing more on building envelopes and almost ignoring the analysis of engineering systems. The actual energy consumption in a building is not evaluated during analysis. Received energy efficiency in a building is of a theoretical nature (as it is supposed to be) and is more suitable for the primary identification of energy efficiency rather than for a detailed definition of possible energy efficiency measures and the evaluation of their interaction (Newsham *et al.* 2009; Scofield 2009). The main problem is great discrepancies among the results presented in the energy efficiency certificate and actual (recalculated under standard conditions) energy consumption results of the building recorded for quite a long period using heat substation meters. In the below presented methodology (Formula 1) of energy audits, clearly indicated variables are used for heat balance dependency determining heat balance:

$$Q_{h,f} = f(t_{int,f}, t_{ext,f}, z_f, A_i, u_i, V_j, n_j, \Psi_P, Q_{P,ex} \\ Q_{P,int}, Q_{AEI}, \Psi_{R,k}, Q_{NR,k}, Q_{Nf,k}), \quad (1)$$

where $Q_{h,f}$ – actual heat consumption in a building (a parameter recorded by heat meters); $t_{int,f}, t_{ext,f}$ – the average indoor and outdoor temperatures; z_f – the analysed period; A_i, u_i – envelope surface areas and heat transfer coefficients; V_j, u_j – volumes of premises and their corresponding air exchange rates; $\Psi_P, Q_{P,ext}, Q_{P,int}$ – the heat gain exploitation coefficient of the building engineering system, indoor and outdoor heat gains (Monstvilas *et al.* 2010; Motuziene and Juodis 2010); Q_{AEI} – heat produced in a building using renewable energy sources; $\Psi_{R,k}, Q_{NR,k}$ – the multiplication of members describing the amount of energy regained in the process of heat recovery; $Q_{Nf,k}$ – the actual losses of the system.

The application of this dependency enables to balance heat demand and actual consumption of the building. It becomes possible since the members of equation $t_{int,f}, t_{ext,f}, z_f, n_j, \Psi_P, Q_{AEI}, \Psi_{R,k}, Q_{NR,k}, Q_{Nf,k}$ are variables, i. e. they are defined by the actual condition of a particular building.

In the case of the energy performance certification method, there is no possibility of balancing the actual consumption of energy in a building. A part of countable core values used for calculations are set in advance by default and cannot be changed, even though they differ from the actual recorded parameters in a building. Among those, indoor temperature $t_{inf,f}$, air exchange rate n_j etc. should be mentioned.

The diagram (Fig. 1) shows energy demand for 11 multi-apartment buildings in Birštonas town when they are evaluated applying the energy performance certification method (excluding heat demand for domestic hot water and electricity consumption) and performing energy audit, i. e. evaluating normalized actual heat consumption by balancing (applying the energy audit method) and actual energy consumption for heating seasons 2007–2008 and 2008–2009.

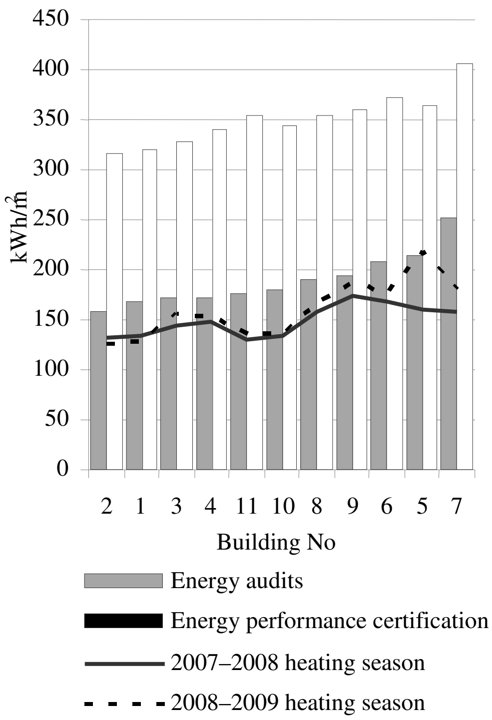

Fig. 1. A comparison of calculation results using energy performance certification, the energy audit method and actual consumption data

As the diagram (Fig. 1) shows, differences in the yearly heat demand, expressed in kWh/m^2, are obvious. While comparing energy demand for the same building but defined using various methods, the difference between them on average reaches 54 percent. The obtained results show that two different methods were used for calculating them and differ significantly in the accuracy of evaluation and used assumptions.

These differences are mainly caused by the fact that the certification methodology contains some values that have been already defined and a person performing certification has no possibility of indicating other values. Air change in the ventilation of a building is determined by the year of constructing the building with an assumption that the building is not airtight, whereas reality may be quite different.

From the building owners point of view, the analysis of energy demand using the energy certification method hardly reflects the actual energy consumption of the building, thus a logical question considering the energy certification methodology arises: how to persuade an energy consumer (building owner) that his/her heating bill will reduce after renovation and that heat savings generated by energy saving measures will cover his/her credit liabilities? How can data differing from real consumption almost twice show actual planned heat savings? Unfortunately, the evaluation of energy efficiency measures currently used in the programme cannot show actual energy savings to be generated by the planned energy efficiency measures. It hardly makes constructive communication between experts and building owners. A persuasion to start renovation based on calculations that are far from actual consumption is inappropriate and unethical.

3. Determination of Economic Feasibility

After the evaluation of the above presented insights into the solutions to information supply on housing renovation, it is essential to look into another aspect, i.e. the economic feasibility of building modernisation as a separate investment project.

Unfortunately, the most efficient implemented renovation measures (increasing air tightness of the building, changing windows, etc.) and the economic feasibility of the remaining measures become quite moderate. The received values of simple payback time criterion are quite poor. The average of the already performed criterion adopted in the projects reaches 15–25 years (Rogoža *et al.* 2008; Kompetenciju centras 2009). Evidently, the evaluation of a renovation project as a separate investment possibility and its comparison with alternative investment possibilities make it unattractive. In this case, the saved energy criterion (SEC) should be invoked as it is created specifically for renovation projects, which shows the price of saved energy (Martinaitis *et al.* 2007):

$$SEC = \frac{I}{S} \times \frac{d}{1-(1+d)^{-n}}, \quad (2)$$

where SEC – saved energy cost in LTL/MWh; I – investment costs in LTL; S – annual energy savings in MWh; d – interest rate; n – life time in the years of energy efficiency measure to be implemented. Logically, if the price of saved energy is smaller than that of the purchased one, the implementation of energy saving measures is feasible, otherwise – investments only increase energy consumption costs, and therefore should be withdrawn.

This concept substantiates the currently popular model for evaluating the efficiency of renovation investment. It is based on the actual costs of heating before renovation and after it. It is stated that following renovation, a building shall consume less energy and the costs of saved energy shall cover payments for credit and interest. It is believed that after renovation, the expenditures of building owners shall be the same; additionally, they shall have better microclimate conditions in the premises, the increased real estate value etc.

Furthermore, when evaluating benefits deriving from building modernization, the two-factor method could be applied (Martinaitis *et al.* 2007). It is naturally understandable that energy efficiency measures and building construction renovation are often interrelated. Building renovation is needed to maintain a building as one engineering system under proper conditions as energy efficiency measures usually improve the general conditions of the building. Logically, renovation costs should be divided accordingly.

As shown in the diagram (Fig. 2), financial liability for building modernisation is correctly distributed. Some building modernisation measures like balancing the heating system or heating substation automation can be fully attributed to energy savings. Those investments or taken financial liabilities on the diagram are indicated as L_E. On the other hand, measures like changing windows, improving wall insulation etc. can be described as having energy saving and building construction renovation components L_T. Finally, there are measures linked only with the renewal of building construction L_C.

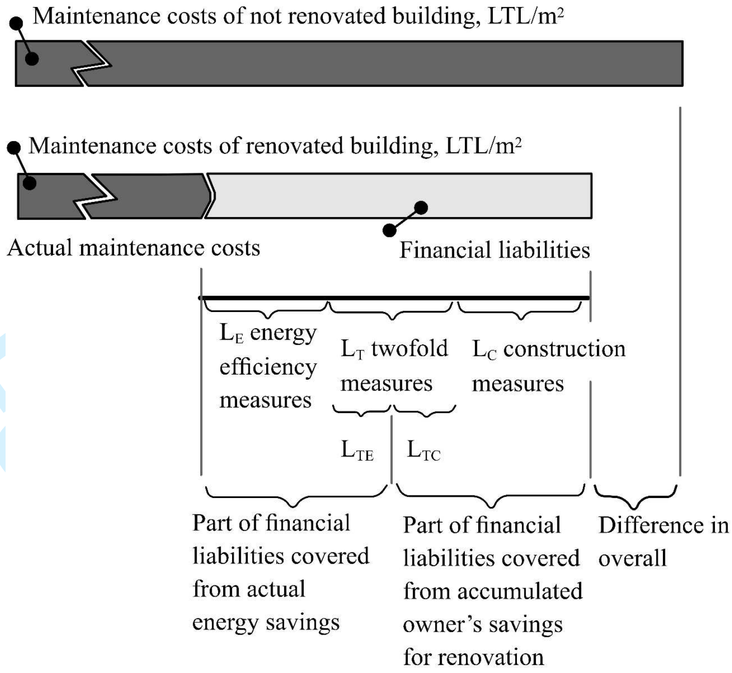

Fig. 2. The twofold method for evaluating building renovation

The evaluation of L_E and L_C creates no difficulties as those building renovation measures can be easily identified. The problem emerges with cost allocation considering L_T, where a part of them should be directed to energy efficiency savings (L_{TE}) and other part (L_{TC}) to the building renovation funds. This division is performed using the following formula:

$$\sum_{i=1}^{n} L_{TC} = \sum_{i=1}^{n} (k_{C_i} L_{T_i}), \tag{3}$$

where k_{C_i} – the wear coefficient of i – building element; L_{T_i} – financial liabilities for particular i – the twofold measure addressed to the building renovation fund:

$$\sum_{i=1}^{n} L_{TE} = \sum_{i=1}^{n} L_{T_i} - \sum_{i=1}^{n} L_{TC}, \tag{4}$$

where L_{TE} – financial liabilities for particular i twofold measure addressed to the savings received from the implementation of energy efficiency measures.

The twofold method suggests that building modernisation should be viewed as a systemic process of a number of building renovations (along its life time) where a part of modernisation costs should be covered from the accumulated funds for building construction rehabilitation. The other part of costs should be covered by actually generated energy savings. Only this method actually reveals the true economic attractiveness of energy efficiency measures.

In order to test the offered support model under actual conditions and identify constraining conditions for its application, the performed calculations are based on data taken from the real renovated building – a standard 5-storey house with 22 flats the total heated area of which covers 1336 m^2. The area of flats reaches 1191 m^2. During renovation, a complex of energy efficiency measures such as the insulation of external walls and roof, the replacement of windows and exterior doors, the modernisation of heat substation and heat system were implemented. The aggregated data on energy demand for the building before and after renovation are presented in Tables 1 and 2.

Table 1. Building energy and envelope data before and after renovation

	Parameters before renovation	Parameters after renovation
Heat demand, MWh	289	132
Heat demand, kWh/m^2	216	99
Heat demand, kWh/m^2	175	57
Air change rate, h^{-1}	0.7	0.33
U_{walls}, W/(m^{2}K)	1.05	0.37
$U_{windows}$, W/(m^{2}K)	2.50	1.65

Table 2. Implemented building modernization measures

Measure name	Wear coefficient	Energy savings, MWh	Investments required, LTL
Insulation of building walls	32 percent	72.65	207915
Changing windows in flats	38 percent	16.78	57334
Changing window in a stairwell	38 percent	14.01	15723
Glazing balconies	38 percent	19.33	49735
Roof insulation	63 percent	17.19	75737
Insulation of stairwell doors	n/a	7.83	6302
Modernisation of a heating system	38 percent	1.65	87083
Sewerage repair and fire alarm	n/a	0	62032.03

These values are received while performing the energy audit of a building; thus, they show the actual situation that may be directly linked to the costs of heating and domestic hot water recalculated under standard outdoor and indoor conditions. After the evaluation of energy demand for the building heating system, demand before and after renovation makes 175 and 57 kWh/m^2 respectively. The effect of implementing energy efficiency measures reaches 65.7 percent.

The implementation of the presented renovation project required the investments of 562 thousand LTL. Investment in 1 m^2 of the flat area amounted to 472 LTL (or 420 LTL per 1 m^2 of the heated area). The made calculations indicate that the annual payments for the period of 20 years considering the heat price equal to 229.99 LTL/MWh and applying the offered scheme of the housing renovation programme will not exceed payments that were prior to renovation. Accordingly, heating bills for the building were equal to 66.4 thousand LTL, whereas after renovation, due to increased energy efficiency, heating bills constitutes only 30.3 thousand LTL. Additional payments for loan return include the annual payment for 20 years, which equals to 31.8 thousand LTL (preferential 3% annual interest rate is applied). The conducted evaluation reveals that following the renovation process, the aggregate costs of the building owners should decrease. In this particular case, after renovation, the planned costs shall be 6.5 percent smaller. Project payback time equals to 16 years.

The results presented above are valid under an assumption of the fixed heat price, i. e. during the whole analysed period, it remains equal to 229.9 LTL/MWh. In order to demonstrate the impact of the heat price on the received results, we analyse payments if the heat price increases by 2 percent annually. The evaluation results are presented in the diagram (Fig. 3).

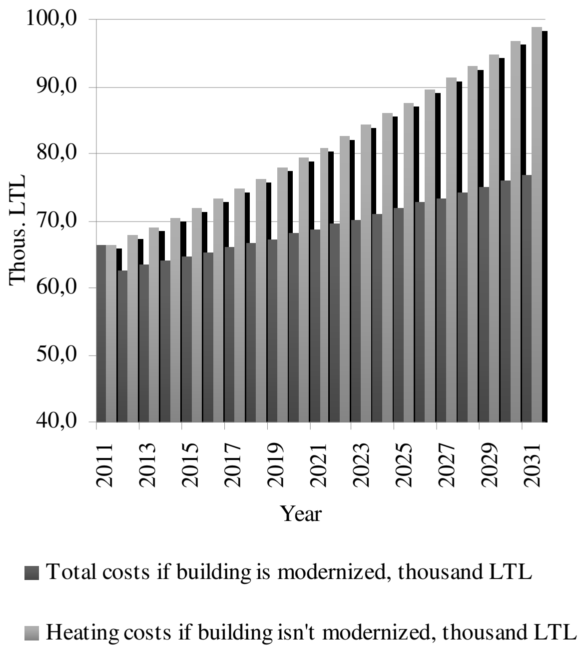

Fig. 3. A comparison of the total costs of renovated and non renovated alternatives

The diagram (Fig. 3) shows the difference between the evolutions of payments in two cases. In the first case, the building is modernized. In the second case, renovation is not launched and the building consumes the initial standard 289 MWh of heat per year. The presented evaluations show that after introducing the consistent growth of the heat price, the building that has not undergone renovation would have much higher heat costs.

The sum of the undiscounted costs of the analysed 20 year period reveals that difference in the expenditures of the renovated and not renovated building reaches 15.7 percent. This fact clearly denies a strong belief of the society that if following renovation the district heat suppliers increase the price, the benefit of renovation shall vanish. On the contrary, the evaluation shows that after renovation, the building owners are better protected from negative corrections in the heat price.

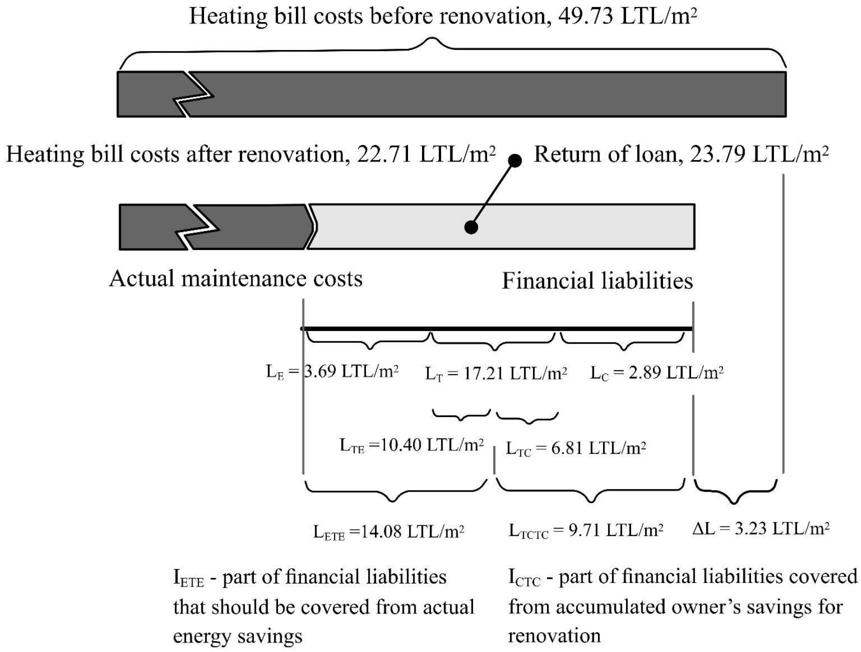

Fig. 4. The application of the twofold method to the actual modernisation project

Despite the existence of actual cost savings, they are too small to represent building modernisation as attractive investment projects, thus the twofold method should be applied. The diagram (Fig. 4) presents building cost allocation using the twofold method. The heating bill of the building under consideration before modernisation was equal to 49.73 LTL/m^2 (of heated area).

The diagram in Fig.4 shows that after modernisation, when the total amount of consumed heat in the building decreased by 54.3 percent, the heating bill was reduced to 22.71 LTL/m^2. It indicates that actual achieved cost savings are 27.02 LTL/m^2. A part of these savings, 23.79 LT/m^2, should be spent to cover loan payments. Up to that is all information that offers the current building modernisation program. However, the twofold method can present more important insights that provide a clear and easy understandable division of financial liabilities between an obligatory collection of funds for building modernisation and financial liabilities set upon generated energy savings. The diagram in Fig.4 shows that only 14.8 LTL/m^2 of financial liabilities during the current building modernisation should be attributed to energy efficiency. The other part should be taken from building renovation funds where resources have to be collected on a monthly basis. Under this condition, the idea of building modernisation becomes much more feasible. Payback time from the previous estimated 16 years drops to 9.

4. Estimation of Limitary Conditions for the Current Support Scheme

Current support for the housing renovation scheme enables to estimate limitary conditions for its application. Considering the heat price as a fixed value, it is possible to identify investment costs under the condition that payments before and after renovation are the same. The evaluation has been performed for different heat price scenarios. The diagram (Fig. 5) presents estimation results indicating marginal investment values depending on the planned savings.

Direct dependencies between planned (or reached) savings and investment demand have been received. As the diagram (Fig. 5) shows, the increasing heat price grows the share of investment to one square meter. For example, if planned heat savings are 110 kWh/m^2/year and the current heat price (229.9 LTL/MWh) is valid, marginal investment into 1 m^2 reaches 380 LTL/m^2. Presuming that the average heat price of the 20 year period is 50 percent higher, marginal investment grows up to 570 LTL/m^2. Obviously, it is logical because higher heat prices generate bigger savings and may result in bigger funded investments.

It appears that having investment demand for the planned renovation project and the calculated effect of energy efficiency measures on heat consumption in buildings, it is possible to determine whether the costs of the building will increase or decrease

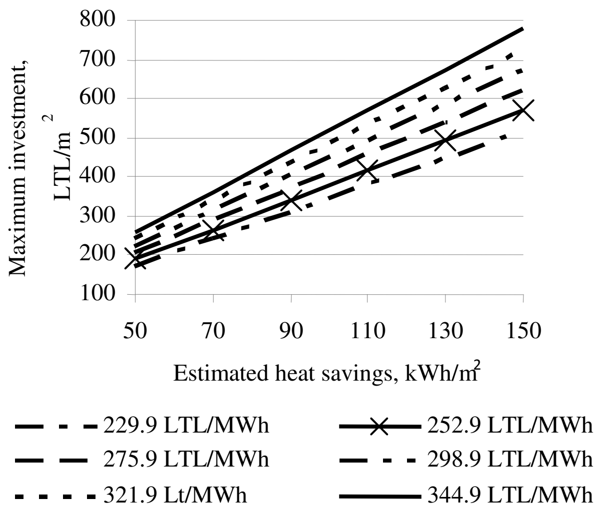

Fig. 5. Relation between planned (achieved) savings and maximum investments

. Unfortunately, there are three unknown factors the risk of which is shifted to the end-user:

- Unreliably evaluated and planned heat savings. The presented differences between the results of the energy performance certificate and energy audit are unacceptable, thus referring to the forecast of energy savings indicated in the certificate is inadvisable. This uncertainty disables the building owners to evaluate the influence of investments on the future costs as it becomes evident only after renovation and its monitoring reveals actual heat savings.
- The building co-owners have no possibility of evaluating the exact investment demand. Unfortunately, due to recent economic processes in the country, perspective evaluations in this field are vague. In order to avoid the artificial exaggeration of renovation costs, the State should limit relative maximum permissible investments to separate energy saving measures. As a step forward, the creation of e-directory for contract works of renovation should be considered.
- Variations in heat prices. In Lithuania, no short-term or long-term projections of district heating prices are being prepared. The building owners have no available information on the planned changes in the heat price. It is mostly determined by objective reasons due to the unpredictable fluctuations of fuel prices.

The estimation of these three factors reveals that the attractiveness of the renovation project basically has a very high degree of risk, even though it theoretically indicates the fact of a non-increase in costs. All risk is given, or to be more precise, imposed on a building's owner. In order to make a decision on renovation, the owner is presented with theoretic evaluations that are far from actual energy consumption before renovation as well as demands after renovation. The probable non-increase of future costs is related to a number of processes and managing possibilities that are highly limited for the building owners. It would be logical for the State to allot a part of risk management burden to itself in case it seeks to enliven the numb process. Having in mind all the ingrained problems in the building sector, the State must take the initiative. The authors of this article are convinced that a part of the risk and functions of the renovation process should be allotted to a third party (controlled by the State). Most importantly, this party should control and confirm the prepared heat savings and ensure their attainment. However, this topic is much wider, and therefore more detailed analysis shall be presented in another article.

5. Discussion

The energy certification method, currently used in the housing renovation process as the evaluation of energy efficiency measures, is not appropriate. The energy certification of buildings was created as a quick and approximate tool in order to make it universal. The values used for certification differ from the actual recorded energy demands of the building. The evaluation methodology includes "stiff" values that may not be changed according to a specific situation of the building and all this raises a question of the correctness of adding together different forms of energy. It is inevitable to refer to the technical-energy audits of the buildings that help with achieving more accurate and correlating with actual energy consumption, and consequently more reliable results. A number of the EU members raise the question if it is worth performing the energy certification of a building in case it has actual energy consumption data on the last couple years. This type of certification is offered to be applied only to building projects and buildings under three years of exploitation.

Technical solutions to building renovation including envelope insulation are well known and widely used. The problems typical of this sphere may be effectively solved by increasing the quality control of construction work. Still, a number of questions arise concerning the measures of renovating the systems of building service. Namely, these systems allow saving wisely heat using internal and external heat gains, changing the behaviour of energy users etc. They help with saving energy giving ability to temporary suspend the use of energy services. The best known example is the reduction of temperature during separate periods of time. The biggest problem is ventilation systems, the necessity of which is frequently unacknowledged by the building owners. Along with the problems of organisation, technical installation difficulties in these systems appear. They tend to reveal themselves especially when deciding on the type of the system: local or central. The suggestion would be to include the installation of the ventilation system as an obligatory measure for renovation. Insufficient attention to this problem could lead to large-scale and long-term health problems.

The scope of housing renovation set by the State is highly questionable. Considering the uneven balance of benefit and risk, it is necessary to change or revise the support scheme. From the State point of view, housing renovation is an unambiguously positive phenomenon (positive changes in the imported fuel balance, saving measures (avoided subsidies), business promotion and increasing employment), whereas all building owners shall have the same or slightly reduced costs at best. Besides, the process risk is imposed solely on the building owners. This allocation of risk is inadequate and has to be revised. It is suggested to establish a renovation fund partially or fully managed by the State. The fund would provide measures for renovation, organise the whole process and retrieve measures accumulated from the savings of the building. Monitoring energy consumption should be performed accordingly in order to determine the actual level of savings. On the other hand, in terms of support, the buildings are not prioritised according to the efficiency of energy consumption. The process should start from the buildings having the worst indicators. Selecting them should be performed and support organised in cooperation with the municipality, heat suppliers and real estate developers. The authors are convinced that the process of renovation doesn't use all of its potential since there is no support for initiatives to seek for higher energy consumption efficiency than minimum requirements stipulated in construction technical regulations (CTR). Although it is not forbidden, nevertheless, no additional promotion is offered. The present situation would be logical and correct if the levels of energy efficiency indicated in CTR corresponded to economical optimum. However, could anyone prove this by actual and publicly available estimations? It has to be admitted and the answer is likely to be no.

With reference to the housing renovation process, additional attention should be paid to the promotion of renewable energy sources. Unfortunately, the current intensity of support does not allow the end-user to see real economic benefits, thus the implementation of these sources becomes slow. It is essential to apply a separate level of promoting renewable energy that would encourage the implementation of alternative energy sources.

6. Conclusions

1. The residential building sector has considerable energy saving potential that is still not utilized. Despite an obvious identification of savings, potentials still remain preventing modernization processes from entering more active and broader application.
2. One of the main reasons is the lack of transparency in the building modernization process. Society cannot receive any tangible guaranties that the declared energy saving benefits will be actually reached. The currently applied building certification method for energy saving estimation is far from accurate. The data do not correspond to actual energy consumption in the building nor actual billing. Intolerance in these estimations amounts up to 54 % due to the fact that the building certification method is incorrect and cannot be used in estimations where precise energy and money savings should be stated and further declared to the building owners.
3. Energy saving estimations received using the energy auditing method are far more accurate and correspond to actual energy consumption. The reintroduction of energy audits in the building modernisation process could decrease uncertainty existing in achievable savings.
4. The introduction of the twofold method could lead to a more comprehensive cost allocation mechanism between energy efficiency and building renovation measures. It would help with solving disputes considering the attractiveness of energy efficiency measures and a need for building modernisation.
5. Building analysis has showed that modernised buildings are less sensitive to fluctuations in the heat price than those where modernisation is not performed. Despite constant loan payments, modernised buildings will be in a better position in a sense of the overall payment rather than non-modernised buildings.
6. The implementation of energy audits could reduce risk for investors. This fact could lead to introducing energy service companies to the building modernization market.

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IŠŠŪKIAI ENERGIJOS VARTOJIMO EFEKTYVUMUI VYKDANT DAUGIABUČIŲ NAMŲ MODERNIZACIJĄ LIETUVOJE

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Santrauka

Straipsnis atspindi autorių poziciją dėl Lietuvoje vykdomos daugiabučių gyvenamųjų namų modernizacijos programos. Tyrimas apima grupės pastatų Birštone analizę ir orientuojasi į tris pagrindines sritis turinčias lemiamą reikšmę bendram daugiabučių namų modernizacijos programos įgyvendinimui. Šios sritys yra: taikomi energijos vartojimo efektyvumo didinimo priemonių identifikavimo ir įvertinimo mechanizmai, faktinių energijos vartojimo duomenų analizė ir pastatų modernizacijos proceso ekonominio patrauklumo vertinimas. Gautos tyrimų išvados rodo, kad daugiabučių namų modernizacijos programa yra tobulintina. Joje apibrėžiama modernizacijos projektų vykdymo ir paramos tvarka turi nemažai prieštaravimų dėl neleistinai didelių faktinių ir skaičiuotinų energijos suvartojimų nesutapimų, energijos vartojimo efektyvumo didinimo priemonių ekonominio efektyvumo nustatymo patikimumo, perdėtos veiklų rizikos koncentravimo galutiniam vartotojui ir pan. Tyrimas pateikia nustatytų problemų apžvalgą bei pateikia rekomendacijas jų sprendimui.

Reikšminiai žodžiai: pastatų renovacija, energijos vartojimo efektyvumas, energiniai auditai, pastatų energinio naudingumo sertifikavimas.

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