ENERGY EFFICIENCY INVESTMENTS IN HOUSING

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Abstract. *Housing is at the core of the European Union's prosperity as it is important to achieve energy saving targets and to combat climate change whilst contributing to energy saving and security. During the programming period 2007–2013, the European Union Cohesion Policy has started playinga new and important role in the process of supporting investments into energy efficiency measures in the housing sector. The increasing need for effective renovation of housing stock, which was constructed in the period when energy resources were cheap, is most notable in Central and Eastern Europe. The use of the European Union fund for the renovation of housing stock in Lithuania servers as a basis for assessing the impact of such investments on energy saving, natural gas import and greenhouse gas emissions.*

Key words: *European Union financial support, investment in energy efficiency, housing, energy savings, natural gas import, greenhouse gas emissions*

Introduction

The building sector is the largest user of energy and greenhouse gase (CO_2) emitter in the European Union (EU) and is responsible for about 40 percent of the EU's total final energy consumption and CO_2 emissions. Renovation of buildings (and especially in the residential sector) is crucial for achieving climate and energy package targets of the 20–20–20 percent reduction of energy consumption and CO_2 emissions and an increased share of renewables by 2020. During the programming period 2007–2013, the EU Cohesion Policy has started playing a new and important role in the process of supporting investments into energy efficiency measures in the housing sector.

The increasing need for an effective management of the housing stock in European cities is most notable in the new Member States. The EU itself recognises that the energy intensity of the new Member States is still significantly higher than in the old Member States. The potential for energy efficiency in Central and Eastern European (CEE) countries is immense: most of the region's old multi-apartment buildings require renovation.

The main purpose of the study was to highlight the importance of investments in energy efficiency in buildings, to present a recent innovative financial instrument suitable for such type of investments in the EU, as well as to assess the impact of the implementa-

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tion of a large-scale energy efficiency programme by using the EU financial support. The object of the study was renovation of multi-apartment buildings. The authors analyse the impact on 1) energy savings (MWh/year), 2) energy security (reduction of natural gas, m^3), and 3) CO_2 savings (t/year) of two specific periods and scales of renovations: 1) renovation of 1000 multi-apartment buildings by 2015; 2) renovation of 23,000 multi-apartment buildings by 2020. Assessment of the impact of the housing stock renovations was carried out using multi-criteria methods based on national and EU statistical data.

Importance of investments for energy efficiency in buildings

The European Council on March 2007 emphasised the need to increase energy efficiency in the EU so as to achieve the objective of reducing by 20 percent the Union's energy consumption by 2020, and called for a thorough and rapid implementation of the priorities established in the Commission Communication entitled "Action plan for energy efficiency: realising the potential". This action plan identified a significant potential for cost-effective energy savings in the buildings sector which comprises about 30 percent of the whole sector's expected energy consumption by 2020. These savings are expected to lead to significant economic, social and environmental benefits. The savings stimulated by the main current EU measures are estimated to result in about 15 percent total energy savings (European Commission, 2008, SEC(2008) 2864).

Buildings now account for about 40 percent of current energy consumption and about 36 percent of CO_2 emissions. The potential of the buildings sector is estimated at the possibility for 28 percent cost-efficient energy savings by 2020 for the sector (or 143 Mtoe final energy) which could be translated into the 11-percent reduction of the total EU final energy consumption and 11-percent reduction of the EU total CO_2 emissions (European Commission, 2008, SEC(2008) 2864). Therefore, reduction of energy consumption in the buildings sector constitutes important measures needed to reduce the EU energy dependency and greenhouse gas emissions.

In the former eastern-bloc countries, the need to refurbish or reconstruct massive estates of pre-fabricated apartment blocks erected by communist regimes is one of the major challenges in their pursuit of convergence towards income and welfare standards prevailing elsewhere in Europe (Turro et al., 2008). Acquisition of housing, proper maintenance, renovation and rehabilitation of the existing housing stock are directly related to both the national economic situation and the income level of the population.

Investments in energy efficiency in housing are crucial for CEE countries as they can deliver multiple benefits. First, investments contribute approximately half of energy-related CO_2 emissions. Second, investments should lead to a reduction of energy use, thus lowering energy bills and reducing the country's dependence on external fuel suppliers. Third, the macroeconomic prognosis implies that the decline of the construction sector in the value added will be much more pronounced in the coming years. The governments, in order to boost the country's economy, could finance housing modernization instead of the construction of new facilities which, especially in financial turmoil, experience oversupply. Fourth, investment in the renovation of housing could create new jobs not only in construction industry, but also in the sectors that supply materials and services to the construction industry itself. In addition, the savings caused by the reduction of energy consumption, plus the additional consumption fuelled by the wages of the additional jobs created, should increase the disposable income of the families; income that, when spent, will generate additional induced benefits to employment (Ürge-Vorsatz, 2010).

Financial insrument for financing investments in energy efficiency

The European Investment Bank (EIB) was established in 1958 by the Treaty of Rome as a long-term lending. The EIB is a non-profit, policy-driven bank of the EU. The institution makes long-term loans for capital investment projects (mainly fixed assets), but does not provide grants. The EIB is one of the largest lenders to the public sector in Europe: in 2009, the EIB lent EUR 79.1 billion in support of the objectives of the EU (European Investment Bank, Projects Financed, 2010).

The EIB's approach to urban investment has evolved pragmatically over the years until the current, i.e. 2007–2013, programming period, responding to the EU policies and instruments. Since urban renewal and social housing, alongside urban transport, became eligible for the Bank funding within the environmental objective in 1988, as well as the mix of financial products within the field of urban development, lending has been increasing at an accelerating rate (European Investment Bank, Sustainable Cities, 2005). In terms of energy efficiency, over the five years (2006–20010), the EIB has contributed some EUR 18 billion to projects which have a direct impact on improving the energy efficiency in and outside the EU. Approximately EUR 1.9 billion was contributed to increase the energy efficiency in building and another EUR 0.5 billion in industry (Idczak, 2011).

Recently, the EIB has started supporting convergence (one of the EU's Cohesion Policy pillars) through special programmes developed in cooperation with the European Commission, to enable the most efficient and sustainable use of Structural Funds in the 2007–2013 programming period. One of the new products, developed by the EIB in cooperation with the European Commission and the Council of Europe Development Bank in 2005, is a new initiative – Joint European Support for Sustainable Investment in City Areas (JESSICA). It is an optional financial instrument intended to address the lack of investment funds to finance the integrated urban renewal and regeneration projects and facilitate accelerated investments in urban areas in the context of the Cohesion Policy (European Investment Bank, JESSICA…, 2007).

The Managing Authorities of the Member States can use payments from their Structural Funds allocations by placing funds into either an urban development fund or a holding fund. Such investments may take the form of equity, loans or guarantees, and encourage the development of partnerships among municipalities, banks and private investors (European Investment Bank, JESSICA…, 2007).

The Programme contributions are in the form of revolving finance to make the investment more sustainable and trigger significant leverage effects. JESSICA is expected to build up a lasting funding legacy of the EU and national public money, to be reinvested in the long term in the field of urban development and regeneration as well as in effective asset management opportunities in cities.

As the EU recognises the need to rapidly mobilise cost-effective energy efficiency improvements in the built environment to achieve the relevant targets, JESSICA servers as an illustration of using the EU funds in the area of energy efficiency. JESSICA is already set to play an important role in this area in such EU countries as Lithuania, Spain, London and Greece. These are expected to channel more than EUR 500 million of long-term capital investment into energy efficiency for housing, public buildings and other spheres of urban infrastructure. The use of one of the largest and most advanced JESSICA operations to date is illustrated in the following section (European Investment Bank, 2010).

The implementation of JESSICA in Lithuania

The majority of the Lithuanian population (66 percent) reside in multi-apartment buildings constructed in 1961–1990 (Programme, 2004). The absolute majority of Lithuanians live in privately owned property, as opposed to leasehold (Ivanauskas et al., 2008).

The bulk of the country's multi-apartment buildings was constructed in the period when energy resources were cheap, which conditioned a poor focus on energy-efficiency measures at the time of building new houses (Serbenta, 2009). The publicly owned rental housing stock was privatised to a high extent; however, no sufficient attention was paid to the establishment of an institutional and legal system for its maintenance and exploitation; for this reason, housing maintenance and poor energy efficiency problems arose. The point is that the additional upfront financial needs for energy efficiency improvements are often considerable. According to the Housing Strategy, 24,000 multi-apartment buildings should be refurbished by the year 2020. Taking into consideration the average investment to the renovation of one multi-apartment building, i.e. approximately EUR 290,000, the total investment need amounts up to EUR 7 billion (Lithuanian Housing Strategy, 2004).

Recent economic trends in Lithuania and in other Member States have implied the deteriorating supply of financing. With the shrinking public budgets and limited access to bank loans during the economic crisis, CEE countries had to turn to EU funds to unlock the potentials, leverage private capital and facilitate the transition towards a low carbon future (CEE Bankwatch Network, 2009).

As part of the negotiations about the new Structural Fund regulations for the period 2007–2013, the EIB was frequently mentioned in the context of housing investment, especially by the new Member States (Expert Working Group, 2007). These negotiations led to and agreement that a new Member State may invest limited amounts of the European Regional Development Fund (ERDF) funds in housing. In this context, the Government of the Republic of Lithuania decided to implement a new innovative tool for financing urban development and suitable for funding of energy efficiency investments, i.e. JESSICA. On 11 June 2009, the Ministries of Finance and of the Environment of the Republic of Lithuania, established the JESSICA Holding Fund Lithuania in an amount of EUR 227 million, which is managed by the EIB on behalf of the Lithuanian authorities. Until 2015, the JESSICA Holding Fund aims to finance 1000 multi-apartment buildings and achieve 30 percent of the effectiveness of energy consumption in the renovated housing stock (Lietuvos Respublikos Vyriausybės nutarimas, 2008)[1]. In accordance with the Programme for Renovation (Modernisation) of Multi-apartment Buildings (Programme, 2004), state support is provided to home owners of multi-apartment buildings built in accordance with the construction permits issued before 1993[2].

The following part of the article will analyse the impact of the implementation of the Programme for Renovation (Modernisation) of Multi-apartment Buildings, using the JESSICA Programme for 1) energy savings; 2) energy security; and 3) CO_2 savings. Since the impacts are determined by the scale and schedule of the Programme, we have investigated the impact of two specific periods and scopes of renovations: 1) renovation of 1000 multi-apartment buildings by 2015 (JESSICA Holding Funds physical output target (Lietuvos Respublikos Vyriausybės nutarimas, 2008)); 2) renovation of 23,000 multi-apartment buildings until 2020 (the Programme's physical output target). The authors make an assumption that the conditions of financing the programme remain the same during both specific periods[3].

The authors use the results of the monitoring studies of the Programme implemented by the Government of the Republic of Lithuania during the period 2005–2009 (Monitoring Studies) as the basis for calculations of the impact of the Programme using JESSICA financial instrument (Rogoža et al., 2007, Rogoža et al. 2008, Daugiabučių..., 2009).

Energy saving

For the purpose of estimating energy saving, the authors calculate the average heated area of one multi-apartment building, based on the figures presented in the Monitoring Studies. The formula of calculating the average heated area is as follows (compiled by authors using information presented in the Monitoring Studies):

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[1] According to the Law on Support for Housing (Law on State Support, 2009), the annual fixed interest rate on the modernisation loans granted to the final beneficiaries will not exceed 3 percent for the whole term of the loan grated for renovation projects, i.e. for a period of up to 20 years.

[2] The article focuses only on the multi-apartment buildings built in accordance with the construction permits issued before 1993.

[3] The scope of the renovation, i.e. 1,000 and 23,000, are preliminary and taken as an indication and illustration of different impact on energy savings, natural gas imports and CO_2. The authors do not take into account the number of the projects that has already been renovated or partly renovated during the period 1990–2010.

$$\overline{S} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M_i} S_j^i}{\sum_{i=1}^{N} M_i} \approx 3.074\,\mathrm{m}^2, \tag{1}$$

where $\overline{S}$ is the average heated area of the multi-apartment building (m^2); N is the number of implemented Monitoring Studies, M_i is the number of multi-apartment buildings assessed in the i^{th} monitoring study, and $S_j^i - i$ is the average heated area of a j^{th} multi-apartment building in the i^{th} monitoring study (m^2).

In order to calculate the annual energy savings, the average heated area of the multi-apartment building per m^2 must be calculated. For this purpose, authors used the following formula which is based also on the results of the Monitoring Studies (compiled by authors and presented in Monitoring Studies):

$$\overline{E} = \frac{\sum_{i=1}^{N}\sum_{j=1}^{M_i} \frac{E_j^i}{S_j^i}}{\sum_{i=1}^{N} M_i} \approx 72.4\,\frac{\mathrm{kWh}}{\mathrm{m}^2}, \tag{2}$$

where $\overline{E}$ is the average heated area of the multi-apartment building (m^2/year), N is the number of implemented monitoring studies, M_i is the number of renovated multi-apartment buildings assessed in the i^{th} monitoring study (number); E_j^i is the average annual energy saving of the j^{th} multi-apartment building in the i^{th} monitoring study (kWh/m^2), and S_j^i is the average heated area of the j^{th} multi-apartment building in the i^{th} monitoring study (m^2).

Taking into account the above calculations, the renovation of 1,000 multi-apartment buildings allows annual savings approximately equal to 222,558 MWh and in case of renovation of 23,000 multi-apartment buildings 5,118,824,8 MWh per year. The MWh value in both cases was calculated using the simplest formula:

$$E = \overline{E} \times N \times \overline{S}, \tag{3}$$

where E is the energy savings per year (MWh), $\overline{E}$ is the average heated area of the multi-apartment building (m^2/year), N = 1000 is the number of renovated multi-apartment buildings, and $\overline{S}$ is the average heated area of the multi-apartment building (m^2).

The figures show that the renovation of 1,000 multi-apartment buildings can save around 1.75 percent of the total household energy consumption reached in 2009 and the renovation of 23,000 multi-apartment buildings around 40.3 percent of the same total energy consumption (see Table 1).

TABLE 1. **Household energy consumption by fuel and energy (%, GWh, MWh) in 2009**

Type of fuel	Energy consumption in households for heating by fuel and energy, %	Household energy consumption by fuel and energy, GWh	Household energy consumption for heating by fuel and energy, MWh
Hard coal	91.2	442.8	403.833.6
Firewood and wood waste	91.4	6, 793.6	6,209.350.4
Fuel oil	70.6	23.8	16,802.8
Liquefied petroleum gases	2.5	492.8	12,320.0
Natural gas	59	1,616.4	953,676.0
Electricity	5.1	2,600.3	132,615.3
Heat	82.8	5,950.2	4,926,765.6
Other fuel	90.5	58.8	53,214.0
		Total	**12,708,577.7**

Source: Statistics of Lithuania.

Reduction of natural gas import

Based on the analysis presented by Nagevičius et al. (2010), the portion of biofuel in fuel mix should increase from 15 percent in 2010 to 70 percent in 2020, i.e. on average by 5.5 percent per year. In order to forecast the long-term value of the price of heating energy, two types of fuels were taken into account, i.e. natural gas and biofuel. The distribution of these two types of fuels in the fuel mix is presented in Table 2.

TABLE 2**. Distribution of biofuel and natural gas in fuel mix by year (percent)**

Year	Portion of biofuel, percent	Portion of natural gas, percent
2010	15.0	85.0
2011	20.5	79.5
2012	26.0	74.0
2013	31.5	68.5
2014	37.0	63.0
2015	42.5	57.5
2016	48.0	52.0
2017	53.5	46.5
2018	59.0	41.0
2019	64.5	35.5
2020	70.0	30.0
2021	70.5	29.5
2022	71.0	29.0
2023	71.5	28.5
2024	72.0	28.0
2025	72.5	27.5
2026	73.0	27.0
2027	73.5	26.5
2028	74.0	26.0
2029	74.5	25.5
2030–2050	75.0	25.0

Based on the Order of the Minister of Economy of the Republic of Lithuania No. 43 of 5 February 2002 on Transmission, Distribution, Supply, Purchase and Storage of Natural Gas (Lietuvos Respublikos ūkio ministro įsakymas, 2002), the caloric value of natural gas cannot be lower than 31.8 Mj/m^2 or 0.11448 MWh/m^2. As heat losses from distribution networks constitute on average 17 percent (Nagevičius et al., 2010), the general reduction of demand for natural gas import could be calculated using the following formula:

$$\frac{K \times \frac{E_s}{(1-N)}}{Q}, \tag{4}$$

where E_S is the heat energy saved by consumers (MWh, equation (3)), K is the portion of natural gas in fuel mix (percent), N is the coefficient of losses from heat supply (percent), and Q is the caloric value of natural gas (MWh/m^3).

Results of calculations of the reduction of natural gas are presented in Table 3.

TABLE 3. **Reduction of natural gas import (m^3/year)**

Year	Natural gas import (m^3/year)	
	In case of renovation of 1,000 multi-apartment buildings	In case of renovation of 23,000 multi-apartment buildings
2015	1,346,801	–
2016	1,217,976	–
2017	1,089,152	–
2018	960,327	–
2019	831,503	–
2020	702,679	16,161,580
2021	690,967	15,892,220
2022	679,256	15,622,860
2023	667,545	15,353,501
2024	655,833	15,084,141
2025	644,122	14,814,781
2026	632,411	14,545,422
2027	620,699	14,276,062
2028	608,988	14,006,702
2029	597,277	13,737,343
2030–2050	585,566	13,467,983

Energy security is one of the key preconditions for economic and national security. Although Lithuania restored its political independence in 1990, it is still energy-dependent on Russia, its main power supplier in all energy sectors – oil, gas and electricity – and still has no alternative energy import sources. The greatest threat the country is facing is the natural gas sector. Currently, Lithuania pays more than any other EU country for natural gas, and the prices are set to rise.

Large-scale renovation programmes such as the ones presented in this study would allow Lithuania to some extent reduce its natural gas imports and thus improve its energy security. Table 3 shows the reduction of natural gas import thanks to renovation implemented and future increase of biofuel in the fuel mix. According to Statistics of Lithuania (Statistics of Lithuania), natural gas import in 2009 amounted to 2,736,800,000 m^3 of which 278,900,000 m^3 were transformed in heat plants. Therefore, by 2015, transformation of imported natural gas in heat plants should decrease by around 0.5 percent in case of a moderate renovation of 1,000 multi-apartment buildings. In case of a large scale renovation programme of 23,000 buildings by 2020, transformation of imported natural gas in heat plants should decrease by around 5.7 percent. A summarised view on the decrease in natural gas import is presented in Annex 1.

CO_2 *emission reduction*

There are two possible ways of calculating CO_2 emissions: 1) without taking into account the specificity of biofuel considered to be CO_2-neutral; 2) taking into account the specificity of biofuel and considering its CO_2 emissions as zero (Europos Komisija, 2007). Burning biofuel also emits CO_2, but this is offset by the fact that it comes from plants, and plants use CO_2 from the atmosphere (Hall et al., 1991). The authors use the following formula for calculating the reduction of millions of tonens of CO_2 per year:

$$M_{CO_2} = E \times \sum_{i=1}^{N} (k_i \times CE_i), \tag{5}$$

where M_{CO_2} is reduction of CO_2 (millions of tonnes per year), E is energy savings per year (MWh, equation (3)), N is the analysed types of fuels (quantity), k_i is the i-portion of i^{th} the fuel in fuel mix (percent), and CE_i is CO_2 emissions of i^{th} fuel (t/MWh).

Table 4 presents data on carbon emission factors (t/TJ) indicated in the Guidelines for National Greenhouse Gas Inventories (Fontelle et al., 2006), which were recalculated into carbon dioxide emission factors (t/MWh).

TABLE 4. **Carbon emission (t/TJ) and dioxide emission (t/MWh) factors**

Type of fuel	Carbon emission factors (t/TJ)	Carbon dioxide emission factors (t/MWh)
Natural gas	15.3	0.2020
Biofuel	26.8[4]	0.3542

Source: Fontelle et al., 2006.

[4] The value was calculated taking into account three different components of biofuel, i.e. 1) solid biofuel (29.9 t/TJ), 2) liquid biofuel (20.0 t/TJ), 3) gas biofuel (30.6 t/TJ).

Table 5 presents the results of calculating CO_2 emission reduction (t/year) using the formula presented in equation (5) as well as carbon dioxide emission factors presented in Table 4.

TABLE 5. **CO_2 emission reduction (t/year)**

Year	Reduction of CO_2 (t/year)		Reduction of CO_2 (t/year), biofuel considered as CO_2 neutral	
	In case of renovation of 1,000 multi-apartment buildings	In case of renovation of 23,000 multi-apartment buildings	In case of renovation of 1,000 multi-apartment buildings	In case of renovation of 23,000 multi-apartment buildings
2015	59,353	–	25,850	–
2016	61,216	–	23,377	
2017	63,079	–	20,905	–
2018	64,942	–	18,432	–
2019	66,805	–	15,960	–
2020	68,668	1,579,362	13,487	310,201
2021	68,837	1,583,258	13,262	305,031
2022	69,007	1,587,153	13,037	299,861
2023	69,176	1,591,048	12,813	294,691
2024	69,346	1,594,944	12,588	289,521
2025	69,515	1,598,839	12,363	284,351
2026	69,684	1,602,735	12,138	279,181
2027	69,854	1,606,630	11,914	274,011
2028	70,023	1,610,526	11,689	268,841
2029	70,192	1,614,421	11,464	263,671
2030–2050	70,362	1,618,316	11,239	258,501

Cumulative energy savings have a direct effect on the reduction in CO_2 emissions from the renovation of multi-apartment buildings. Reductions depend on the type of fuel, proportions of different fuel types in the fuel mix, CO_2 emission factors, and calculation of biofuel impact on CO_2 emission. By implementing a moderate renovation of 1000 buildings by 2015, it is expected to save around 0.3 percent of total CO_2 produced by all economic activities in 2009 (Statistics of Lithuania)[5]. In comparison, a large-scale renovation could help saving around 7.3 percent by all economic activities in 2009. A summarised view on the decrease in CO_2 is presented in Annex 2.

[5] Calculating biofuel as emitting CO_2

Conclusions

Housing is at the core of the EU prosperity as it is important to achieve the EU energy savings targets and to combat climate change whilst contributing to energy savings and security. The adaptation of the JESSICA instrument to the housing modernisation projects in Lithuania is an example of using the EU Structural Funds for increasing energy efficiency in the housing sector. Essentially, several related conclusions could be offered, based on the calculations presented in this article. Investments in energy efficiency in housing lead to the reduction of energy use, thus lowering energy bills and reducing the country's dependence on external fuel suppliers as well as reducing CO_2 emissions.

The results presented above indicate that larg-scale renovations (in case of renovation of 23,000 multi-apartment buildings) would deliver very substantial reductions in the energy used by saving some 40 percent of the Lithuanian household energy consumption which corresponds to saving 5.2 TWh per year. Respectively, the results of renovation of 1,000 buildings would be quite moderate, allowing to save around 1.75 percent of Lithuanian household energy consumption, i.e. about 0.2 TWh per year.

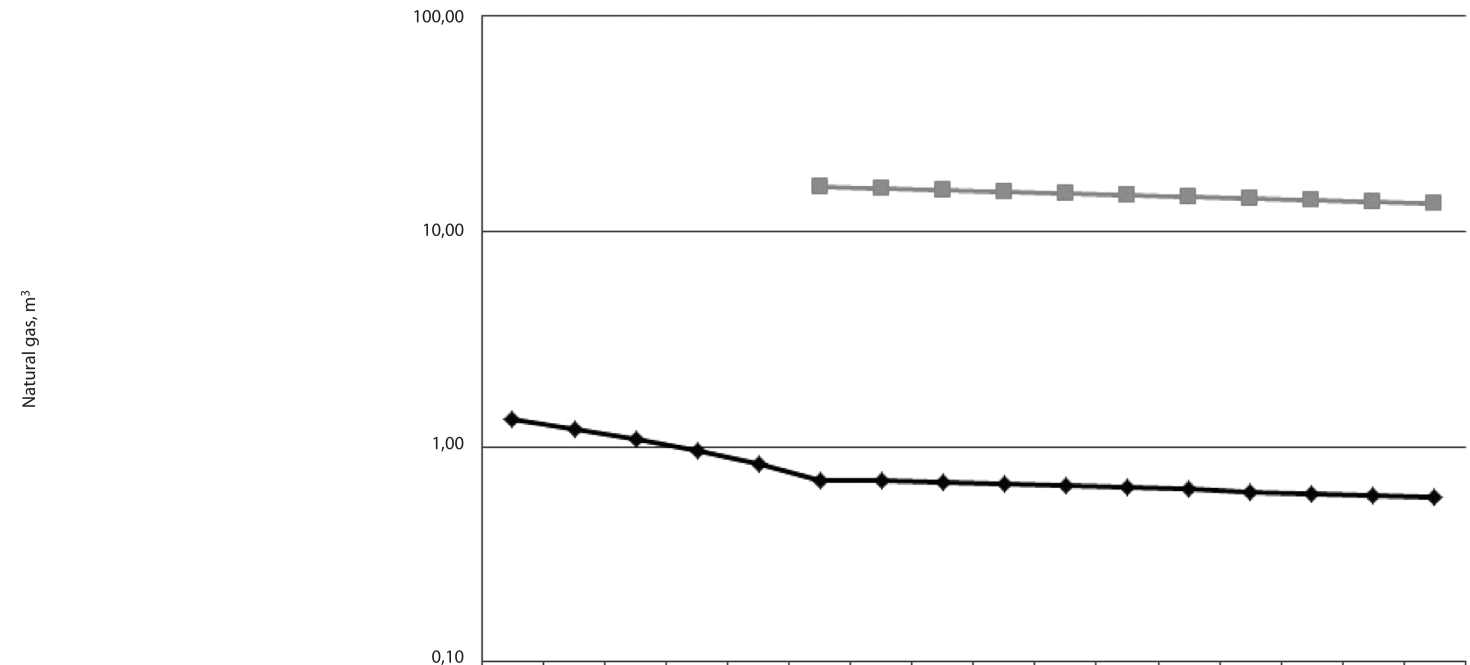
A positive effect of housing renovation is observed in reducing the dependence on imported natural gas. Natural gas import in 2009 amounted to 2,736,800,000 $m^{3,}$ of which about 10 percent were transformed in heat plants. The results presented in the article show that by 2015 the transformation of imported natural gas in heat plants should decrease by about 0.5 percent in case of the moderate renovation of 1,000 multi-apartment buildings. In case of the large-scale renovation programme of 23,000 buildings by 2020, the transformation of imported natural gas in heat plants should decrease even by some 5.7 percent. These reductions are especially important considering Lithuania's dependence on a foreign energy system in all energy sectors and especially in the sector of natural gas.

With regard to reduction of carbon emission, the implementation of the moderate renovation of 1,000 buildings by 2015 is expected to save nearly 0.3 percent of total CO_2 produced by all economic activities. In comparison, a large-scale renovation could help saving about 7.3 percent of total CO_2 produced by all economic activities in 2009.

In addition, taking into account the general aim of the EU financial instrument which Lithuania is using to increase energy efficiency in housing, JESSICA will contribute to creating a sustainable financial mechanism aimed at managing various housing-related problems in urban areas, as well as more general social, political and economic policy agenda challenges, such as better living conditions, new business opportunities, an increased market value of real estate, as well as improved air and life quality and health. Finally, the energy efficiency programme designed with the EU support during the period 2007–2013 could become a pattern to be replicated in future EU Structural Funds programming periods.

Annex 1

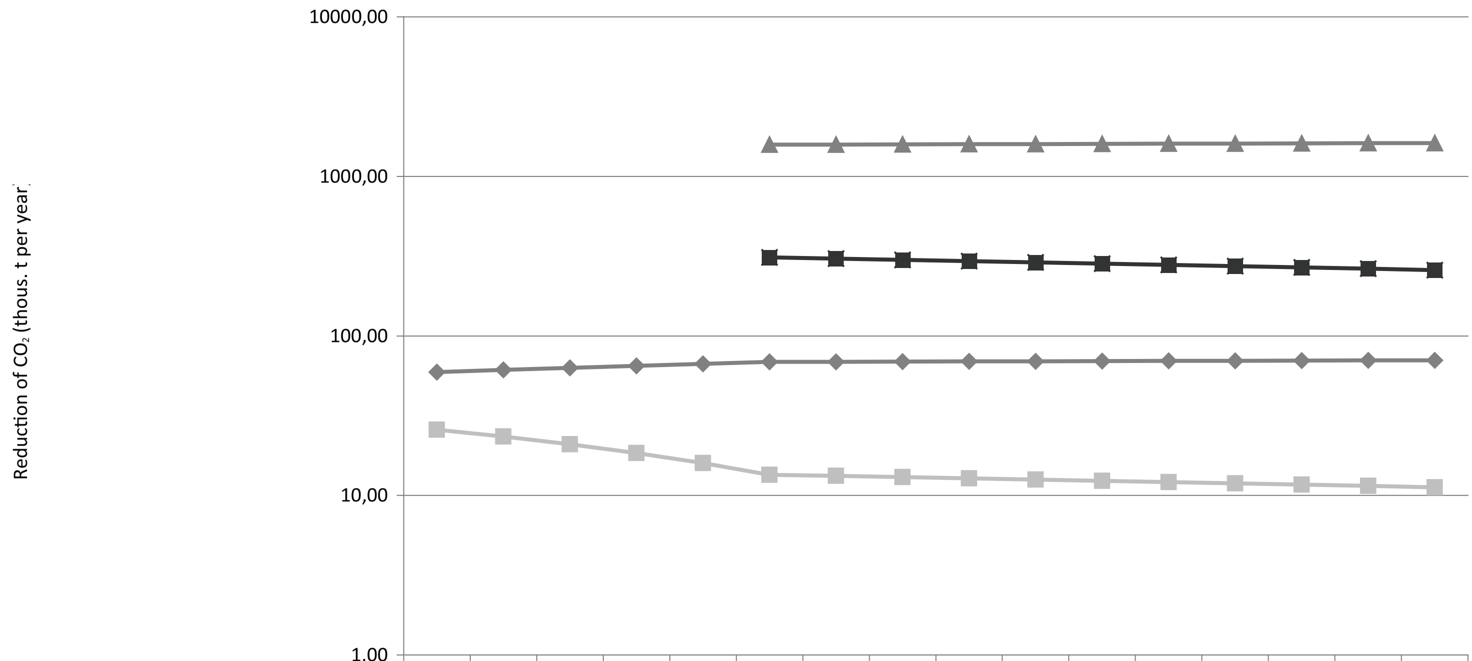
FIG. 1. Reduction of natural gas import, m³ million



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030–2050
Renovation of 1000 multi-apartment buildings (m³ mill.)	1,35	1,22	1,09	0,96	0,86	0,70	0,69	0,68	0,67	0,66	0,64	0,63	0,62	0,61	0,60	0,59
Renovation of 23 000 multi-apartment buildings (m³ mill.)						16,16	15,89	15,62	15,35	15,08	14,81	14,55	14,28	14,01	13,74	13,47

A n n e x 2

FIG. 2. **Reduction of CO_2, thous. t per year**



	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030-2050
Renovation of 1000 multi-apartment buildings	59,35	61,22	63,08	64,94	66,81	68,67	68,84	69,01	69,18	69,35	69,51	69,68	69,85	70,02	70,19	70,36
Renovation of 1000 multi-apartment buildings [biofuel considered as CO_2 neutral]	25,85	23,38	20,90	18,43	15,96	13,49	13,26	13,04	12,81	12,59	12,36	12,14	11,91	11,69	11,46	11,24
Renovation of 23000 multi-apartment buildings						1579,36	1583,26	1587,15	1591,05	1594,94	1598,84	1602,73	1606,63	1610,53	1614,42	1618,32
Renovation of 23000 multi-apartment buildings [biofuel considered as CO_2 neutral]						310,20	305,03	299,86	294,69	289,52	284,35	279,18	274,01	268,84	263,67	258,50

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