Approved
by Protocolar Decision No 18
of the Government of the Republic of Lithuania
of 31 March 2021

LONG-TERM RENOVATION STRATEGY OF LITHUANIA

2021

CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS AND TERMS

Abbreviation	Explanation
RED	Directive 2009/28/EC on the promotion of the use of energy from renewable sources
BETA	Housing Energy Efficiency Agency, Public Institution (*VšĮ Būsto energijos taupymo agentūra*)
CPR or Common Provisions Regulation	Regulation (EU) 2018/1999 on the Governance of the Energy Union and Climate Action
BPIE	Buildings Performance Institute Europe
Cost-optimal study	Study on the establishment of cost-optimal minimum levels of energy performance requirements for buildings in accordance with the principles of the benchmarking methodology set out in the Delegated Regulation (EU) No 244/2012 of the European Commission of 16 January 2012
DH	District heating
NZEB	Nearly zero energy building
OECD	Organisation for Economic Co-operation and Development
ME	Ministry of Energy
EPC	Energy performance class
EED	Directive 2012/27/EU on energy efficiency, amending Directives 2009/125/EC and 2010/30/EU and repealing Directives 2004/8/EC and 2006/32/EC
LTRS	Long-term renovation strategy
LDHA	Lithuanian District Heating Association
NECP	National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030
RPR	Real Property Register
Amending Directive	Directive (EU) 2018/844 of the European Parliament and of the Council amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency
Building stock	Buildings in the national building stock consuming thermal energy
EPB	Energy performance of a building
EPBD	Directive 2010/31/EU on the energy performance of buildings, and Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings and Directive 2012/27/EU on energy efficiency
RC	Centre of Registers, State enterprise (*Valstybės įmonė Registrų centras*)
RBR or Recommendation	Commission Recommendation (EU) 2019/786 of 8 May 2019 on building renovation
SPSC	Construction Production Certification Centre, State enterprise (*Valstybės įmonė Statybos produkcijos sertifikavimo centras*)
GHG	Greenhouse gas
The Green Deal	The European Green Deal provides a roadmap for action to ensure the sustainability of the EU economy, while transforming climate and environmental concerns into opportunities in all policy areas and ensuring that the transition is equitable and inclusive for all.

SUMMARY

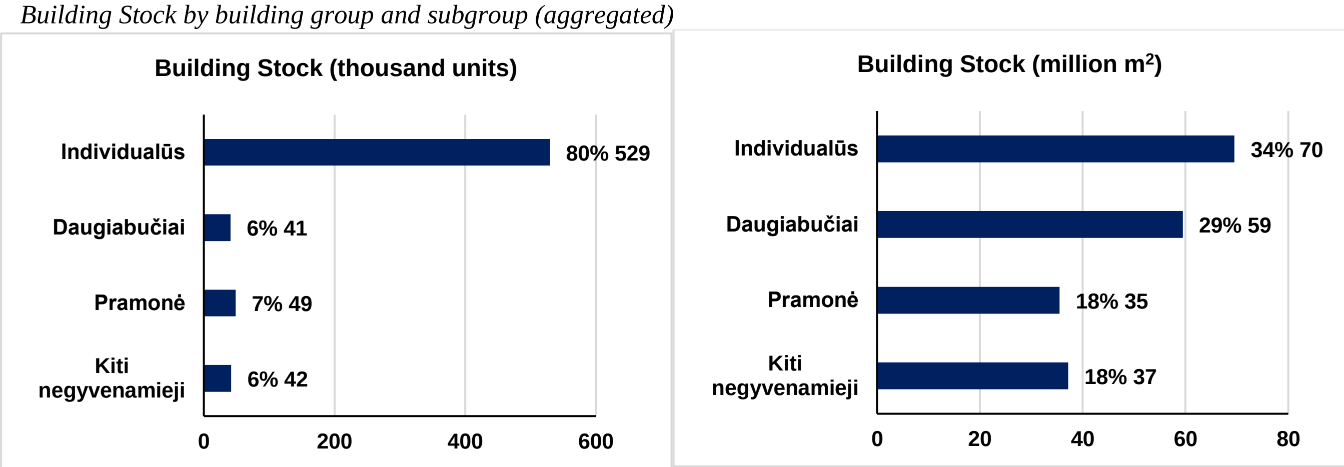
Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 amending Directive 2010/31/EU on the energy performance of buildings (the 'EPBD') and Directive 2012/27/EU on energy efficiency (the 'EED') (the 'Amending Directive') requires Lithuania to prepare a long-term renovation strategy to support the renovation of the national building stock by ensuring:

1. energy efficiency in the building stock;
2. decarbonised building stock by 2050;
3. favourable conditions for the cost-effective conversion of existing buildings into nearly zero-energy buildings.

Overview of the national building stock

According to the data of the RPR as of 31 December 2019, 2.6 million buildings with a total area of 235.3 million m^2 were registered in Lithuania. The Strategy only explores the building stock, which excludes buildings that are not relevant in the context of the LTRS, i.e. buildings that are not subject to the energy performance requirements of the building codes. The building stock consists of 661 thousand buildings with a total area of 201.7 million m^2 (see figure below).

Building Stock by building group and subgroup (aggregated)



Source: RPR data (31-12-2019)

To summarise the characteristics of the building stock, it can be observed that:

- only 2% of the buildings of the building stock (7% of the surface) are public (municipal and state) property, i.e. only this part of the transformation of the building stock can be reliably planned and controlled from a public perspective. The rest of the building owners must make their own decision to participate in the renovation;
- almost half (45%) of the building stock consists of mixed ownership, i.e. managed by both public and private, as well as joint owners. This may further complicate the decision-making process of building owners.
- 66% of the surface of the building stock consists of buildings constructed between 1961 and 1992. The architectural and structural diversity of buildings in this construction period is not great. This creates preconditions for the implementation of repetitive (standard) renovation solutions;
- 75% of the surface of the building stock was built before 1992. Accordingly, at the end of the LTRS' implementation (2050), most of the existing building stock will be over 60 years old, and its renovation will be mandatory to continue its operation.

The EPBD provides that the LTRS may include actual (measured) or estimated (calculated) energy consumption. The Strategy assessed the calculated energy consumption of the building stock.

The basis for the estimated thermal and electrical energy consumption is data on the heated area of buildings, energy performance class, and energy production source. 17% of buildings in Lithuania have an energy performance certificate.

The energy consumption of the building stock was calculated by assigning an energy performance class attribute to all buildings, considering their construction year, and adjusting it based on other publicly available data (e.g. independently implemented energy efficiency measures). The energy production structure of buildings has been calculated considering the data of the annual energy and fuel balance of the Department of Statistics:

- the building stock consumes ~40.8 TWh of primary energy and emits ~5.3 mtCO_2 emissions per year;
- Residential buildings account for 2/3 (63%) of the primary energy consumption of the total building stock, including 34% consumed by private houses, and 29% by multi-apartment buildings;
- 4/5 (78%) of the total primary energy consumption of the building stock is used by buildings in energy performance class lower than C.

Identifying the most cost-effective renovation options

Article 2a(1)(b) of the EPBD provides that each LTRS shall encompass 'the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building;'.

To identify the most cost-effective renovation options, a list of renovation options/measures has been developed, the investment needed to implement the measures, and the economic benefits of the measures have been assessed. Measures with the best value for money (per euro invested, generating the highest economic benefits) are the most cost-effective.

The assessment of the most cost-effective renovation measures was carried out at the level of packages of measures, rather than individual measures, to maximise the potential benefits of complex renovation, while maintaining an integrated approach to the building as an engineering unit and considering the accumulated experience of Lithuania and other EU countries. The renovation packages are structured so that each package includes a set of renovation measures needed to achieve a specific energy performance class, ranging from class C to class A++. In addition, four partial renovation packages have been developed to assess the effectiveness of partial renovation.

In assessing the economic value for money of the renovation packages, only those economic benefits that can be reliably estimated and have the highest potential to be converted into real cash flow have been assessed:

- value of the energy saved – the discounted value of the of the sum of the energy savings over 30 years, multiplied by the price;
- value of the reduced CO_2 emissions – the discounted value of the of the sum of the CO_2 reductions over 30 years, multiplied by the price;
- GDP increase – the projected impact of investments in renovation measures on the country's GDP.

The results of the determination of the most cost-effective renovation method show that the maximum economic returns (the difference between economic benefits and investment) at the level of the building stock are in energy savings of 45–55%. These savings would be achieved if the building stock were transformed into energy performance class A or B (by applying RES measures). Accordingly, it is seen as a cost-effective way of transforming the building stock.

Indicators for implementing the renovation strategy

The long-term renovation strategy of Lithuania aims to transform the existing building stock so that it is energy efficient (complying with the conditions for conversion to near-zero energy buildings), decarbonised, and in line with the principles of universal design by 2050.

To implement this goal, the following indicators are set to be achieved by 2050 (compared to 2020):

- to reduce the annual primary energy consumption of the building stock to 16.2 TWh (~60%);
- to reduce the annual consumption of primary energy from fossil fuels in the building stock to 0 TWh (100%);
- to reduce the annual CO_2 emissions of the building stock to 0 mtCO_2 (100%).

It is important to note that the building stock, as an energy consumer, is an integral part of the energy sector. The transformation indicators of the building stock described above have been established assuming that the energy sector will transform in parallel to respond to changing consumer (the building stock) needs.

The figure below illustrates the dependence of the transformation of the building stock on the transformation of the energy sector:

- column '2050' shows the indicator target values that could be achieved only after the transformation of the building stock has been carried out, i.e. after the implementation of renovation measures to increase the energy efficiency of buildings to the specified extent, and the replacement of non-RES individual production sources with RES;
- column '2050 +' shows the indicator target values set by the LTRS which could be achieved through the transformation of both the building stock (energy consumption) and the energy sector (energy production).

Transformation indicators of the building stock

The preliminary indicators for the implementation of the LTRS for 2030, 2040, and 2050 are set out in the table below.

Indicators targeted by the renovation strategy

Indicator	**Unit of measure**	**2020**	**2030**	**2040**	**2050**
R1. Primary energy consumption per year	GWh	40 827	34 759	25 888	16 162
R2. Primary energy consumption per year (compared to 2020)	(%)	100%	85%	63%	40%
R3. Primary energy (non-RES) consumption per year	GWh	26 407	19 865	10 369	27
R4. Primary energy (non-RES) consumption per year (compared to 2020)	(%)	100%	75%	39%	0%
R5. CO2 emissions	$ktCO_2$	5 287	4 003	2 108	22
R6. CO2 emissions (compared to 2020)	(%)	100%	76%	40%	0%
R7. Area of inefficient buildings (class D and lower)	thousand m^2	108 924	85 887	54 043	19 981
R8. Consumption by inefficient buildings (class D and lower)	GWh	31 601	24 208	14 306	3 717
R9. Consumption by inefficient buildings (class D and lower) (compared to 2020)	(%)	100%	77%	45%	12%
R10. Number of renovated buildings	units	58 774*	99 281**	255 421**	436 008**
R11. Share of renovated buildings	(%)	8%*	17%**	43%**	74%**
R12. Area of renovated buildings	thousand m^2	29 471*	27 819**	67 233**	109 534**
R13. Area of renovated buildings	(%)	15%*	17%**	41%**	66%**

**New and renovated buildings in energy performance class B and higher by 2020.*
***Buildings to be renovated from 2021 with intermediate indicators for 2030, 2040, and 2050*

To achieve the renovation paces necessary for the transformation of the building stock, a 'run-up' period is needed to develop support packages, make the necessary changes to legislation, and allow the construction and financial sectors to adapt their resources, processes, etc. The table below shows the increase in the number of buildings planned to be renovated per year, which reflects both the run-up period and the priority given to larger buildings (multi-apartment buildings) at the beginning of the LTRS implementation period.

Renovation paces: the number of buildings under renovation per year

Building benchmark	**Unit of measure**	**2021–2023**	**2024–2030**	**2031–2040**	**2041–2050**

Multi-apartment buildings	units/year	760	1 086	1 083	934
Private houses	units/year	6 500	8 485	12 702	14 935
Industrial facilities	units/year	308	428	682	816
Other non-residential buildings	units/year	518	719	1 147	1 373
Total	**units/year**	**8 086**	**10 717**	**15 614**	**18 059**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The estimated investment needs for the renovation implementation are shown in the table below.

Investment needs for the renovation implementation per year

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	EUR million/year	286	419	487	492
Private houses	EUR million/year	328	475	844	1 202
Industrial facilities	EUR million/year	88	136	258	374
Other non-residential buildings	EUR million/year	166	255	483	700
Total	**EUR million/year**	**867**	**1 286**	**2 071**	**2 767**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The estimated need for subsidies to implement the renovation are shown in the table below. The need for subsidies has been calculated based on the funding intensity of the renovation support measures currently in place, where 30% of the investments are financed. In the case of multi-apartment buildings, support for drafting investment projects and project administration (‘soft part’) was additionally assessed, accounting for an additional 10% of investments.

Subsidy needs for the renovation implementation per year

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	EUR million/year	114	168	195	197
Private houses	EUR million/year	98	143	253	360
Industrial facilities	EUR million/year	27	41	77	112
Other non-residential buildings	EUR million/year	50	77	145	210
Total	**EUR million/year**	**289**	**428**	**670**	**879**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

A successful transformation of the building stock would result not only in the direct benefits (energy savings and reduced CO_2 emissions) but also the wider benefits of renovation. The table below provides a summary of the estimated direct and wider benefits.

Benefits of the LTRS implementation (real value, not discounted)

Indicator	Unit of measure	2021–2030	2031–2040	2041–2050	Total for 2041–2050	Total for the life cycle
Renovated buildings	units	99 281	156 141	180 587	**436 008**	436 008
Renovated buildings	thousand m2	27 819	39 414	42 301	**109 534**	109 534
Primary energy savings	GWh	30 799	107 394	202 883	**341 076**	739 949
Reduced CO2 emissions	ktCO2	6 504	22 803	43 261	**72 569**	157 947
Investment	EUR million	11 603	20 714	27 667	**59 985**	59 985
Economic benefits						
N1. Value of energy savings	EUR million	1 235	4 736	9 390	**15 360**	33 323
N2. Value of reduced CO2 emissions	EUR million	185	1 024	3 297	**4 506**	9 807
N3. Increase in GDP	EUR million	5 801	10 357	13 834	**29 992**	29 992
N4. Improved human health and working capacity	EUR million	7 221	16 117	26 520	**49 859**	73 123
N5. Increase in the value of residential	EUR million	831	1 615	2 083	**4 529**	4 529

housing						
N6. Reduction of pollution	EUR million	55	288	857	**1 201**	2 606
N7. Reduced allowances	EUR million	32	89	147	**268**	268
Economic benefits (total):	**EUR million**	**11 910**	**24 842**	**38 600**	**75 351**	**100 020**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Considering the above data, it is important to note that a significant share of the benefits is transferred to the period after the renovation implementation (i.e. after 2050), e.g. a building renovated in 2050 will save energy until 2079. However, even over the implementation period of the LTRS (2021–2050), the benefits of renovation significantly outweigh the investments required for implementation.

Model and roadmap for implementing the renovation strategy

To achieve the LTRS indicators described above, more than 75% of the building stock must participate in renovation over a 30-year period. In Lithuania, only 2% of the building stock ownership is public (state or municipal ownership), while the remaining 98% is private (i.e. owned by natural persons or legal entities). Accordingly, to get a breakthrough, the benefits of renovation need to be convincing to most building owners.

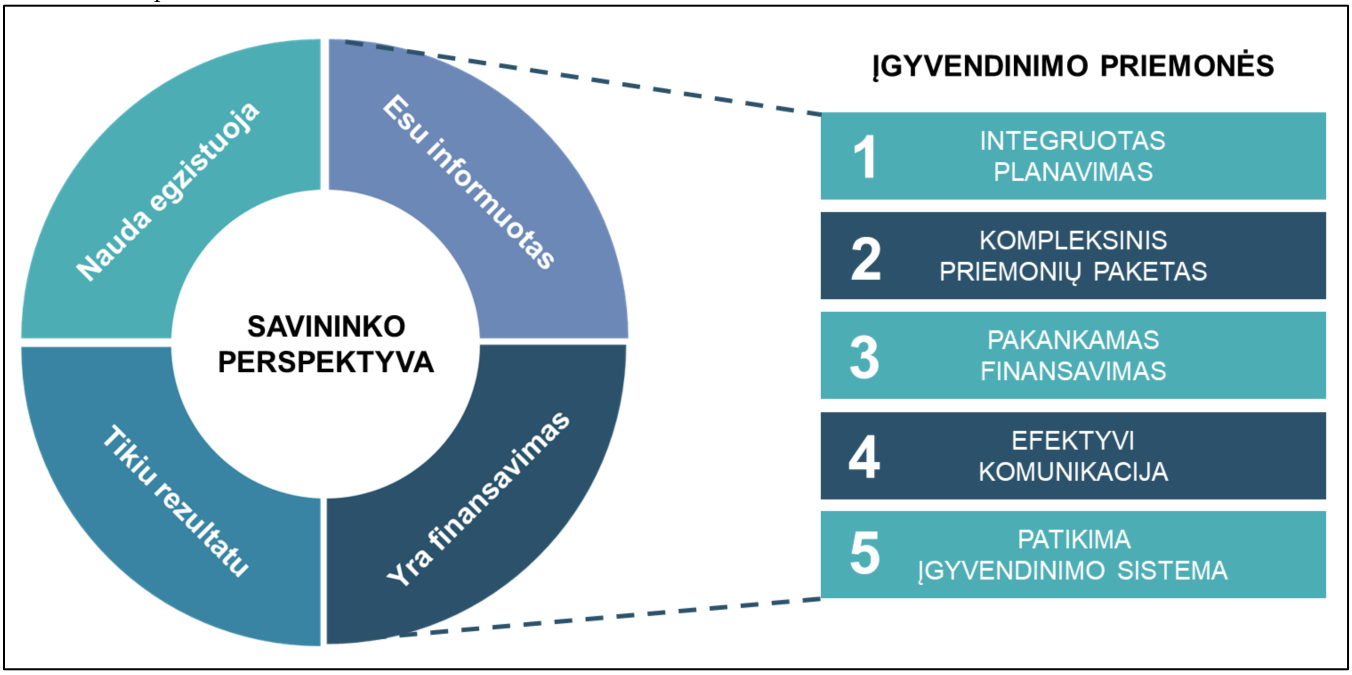
To achieve this result, the LTRS implementation model needs to be focused on the building owner, their expectations, and the removal of key obstacles hindering their decision to participate in renovation.

Various studies and surveys present different expectations of building owners, and the typical obstacles that hinder owners' decision to participate in renovation. However, it can be summarised that a building owner will participate in a renovation when they believe that the benefits of the renovation will outweigh their investment.

For a building owner to believe in the benefits of renovation, several key conditions must be met:

- **Benefits to the owner must be available objectively**.
- **The owner must be informed of the existing benefits**: it is important to assess that the owner's investment is financial, and the benefits of renovation are multifaceted (not only energy savings and reduced costs, but also increase in housing value, improved social environment, etc.); therefore, the owner must be made aware of the full range of opportunities and benefits of renovation.
- **Financing solutions need to be in place**: even if a building owner hopes to benefit from the renovation, they will not participate if they do not have the financial means for that.
- **There must be reasonable assurance of the effectuation of the benefits of the renovation**: even if a building owner expects to benefit from the renovation and has attractive financing options, they are unlikely to participate in the renovation if they do not believe that the intended result will be achieved.

Renovation implementation model



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Key implementation measures of the LTRS:

1. Integrated planning. The renovation process is fragmented, different stakeholders are involved, renovation has a direct impact on related sectors (e.g. energy infrastructure planning, urban planning, regional development planning, social welfare, etc.), and the targets set by the LTRS are directly dependent on the scenarios of the energy sector. Accordingly, the transformation of the building stock projected in the LTRS requires basic, managerial decisions in the planning stage:

- Integration of the LTRS indicators into the legislative framework.
- Establishment of an interinstitutional committee, working group or similar organisational unit to act as the LTRS project manager, i.e. to bring together the competences of key stakeholders and to be responsible for planning, coordinating and monitoring the implementation of the LTRS.
- Development of a comprehensive, consumer-oriented package of support measures.
- Elaboration of the LTRS indicators at the municipal level, delegating to municipalities the responsibility for their implementation, in parallel providing the necessary funding and tools for implementation.
- Establishment of a monitoring system and ensure periodic updating of the target indicators in line with progress in implementation.

2. Comprehensive package of support measures. The support package should be consumer-oriented and focused on the implementation of specific LTRS indicators and address three key challenges:

- To ensure sufficient depth and complexity of the transformation, i.e. to achieve a deep, essential, integrated transformation of the building stock with related infrastructure (DH and electricity networks, streets, urban spaces, etc.), thus maximising not only energy savings but also other essential renovation benefits.
- To ensure the required pace (scope) of transformation without sacrificing either the depth or quality of the renovation or the sustainability of the transformation.
- To ensure the replacement of fossil fuel sources of production.

The main elements of the renovation package are:

- Energy efficiency requirements (transformation depth) increased to energy efficiency class B/A.
- Targeted zero CO_2 emissions (eliminating fossil fuel sources of production).

- Prioritised district renovation (integration with related infrastructure, pace of transformation, economies of scale).
- Partial renovation is possible (flexibility, consumer focus).
- Aggregation of projects (pace of transformation, economies of scale, financing solutions).
- Industrialisation of construction, building ‘ex works’ (pace of transformation, economies of scale, quality assurance, smart technologies).
- Solutions to ensure the sustainability of the transformation and implement the principles of the circular economy.

3. Adequate financing. The support measures must be accompanied by financing solutions for the entire necessary financial flow of the owner during the renovation period, so that the owners of the buildings can and are willing to invest in the renovation.

The intended breakthrough in renovation will require significantly higher investment. According to preliminary estimates, to meet the LTRS milestones, the renovation of the building stock will require an average investment of EUR 1.1 billion per year up to 2030; the investment needs will grow to up to EUR 3 billion a year in subsequent periods, in 2050.

Accordingly, the provision of funding must address two main issues:

- **Securing of funds for the state-funded share (subsidies).** Existing sources will become scarce by 2030; therefore, new sources need to be explored, in particular to benefit from the European Union funds (e.g. through the inclusion of renovations in the 2021–2027 programmes), and planned initiatives (e.g. the European Green Deal Investment Plan).
- **Development of investment financing solutions for building owners**. The predicted significant increase in the owner’s investment financing needs is unlikely to be satisfied by the existing financing solutions. Accordingly, the ability to create and offer to the market financial measures with a high leverage effect[1] and involving private funds, pension funds and international financial institutions is of great importance for ensuring financing.

It is important to note that other renovation measures applied may have a significant impact on reducing the need for renovation (e.g. increase in energy prices, pollution taxes) and increasing the availability of financing (e.g. merging projects).

4. Effective communication. Effective communication should inform the target audience not only about renovation packages, success stories, etc., but should also highlight two additional key messages:

- The benefits of renovation are multi-faceted and go beyond energy savings.
- In the long term, energy inefficient, low-technology buildings have no choice to participate or not to participate in renovation.

The owner’s investment is financial, while the benefits of renovation are multifaceted (not only energy savings and reduced costs, but also increase in housing value, improved social environment, improved health, building security, etc.). Accordingly, for a building owner to believe in the benefits of renovation, he must be made aware of the full range of opportunities and benefits of renovation. This is particularly the case where, due to the inclusion of incomplete costs, the price of energy is low and, as a result, the financial benefits of renovation are not a sufficient motivation to participate in renovation.

The essential factors that make renovation inevitable:

- Poor technical condition of most of the buildings (by 2050, part of the buildings will have to be renovated with own funds or through state-supplied measures).
- Lithuania, as an EU country, must comply with the provisions of EU strategic documents (regulations, the Green Deal, etc.). Fulfilling EU obligations is part of being in the EU.

[1] Instruments with a 1:5 leverage effect are currently being developed in the renovation of multi-apartment buildings, i.e. aiming to leverage 5 euro from the private sector or other third parties for every euro of public finance.

- Accordingly, disciplinary measures (pollution taxes, restrictions on the commercialisation of inefficient buildings, etc.) intended to manage irresponsible and irrational behaviour of building owners will inevitably appear alongside incentives to participate in renovation.

Communication on the inevitability of renovation should focus on two segments:

- Building owners (motivating them to participate in renovation).
- Representatives of construction, design, financing and other stakeholders involved in renovation (providing assurance that public policy on this issue is clear, binding and long-term).

5. Reliable implementation system. To attract both building owners and to ensure the achievement of renovation indicators, a reliable and smooth renovation implementation system is necessary.

Even if the building owner believes in the benefits of the renovation and has attractive financing options, they may decide against the renovation if they face administrative obstacles (both in the planning and implementation stage), as the process will require significant time investments or competencies that they do not have.

To ensure a smooth process and to take into account the needs of building owners, it is necessary to approach building owners both physically and in response to their needs:

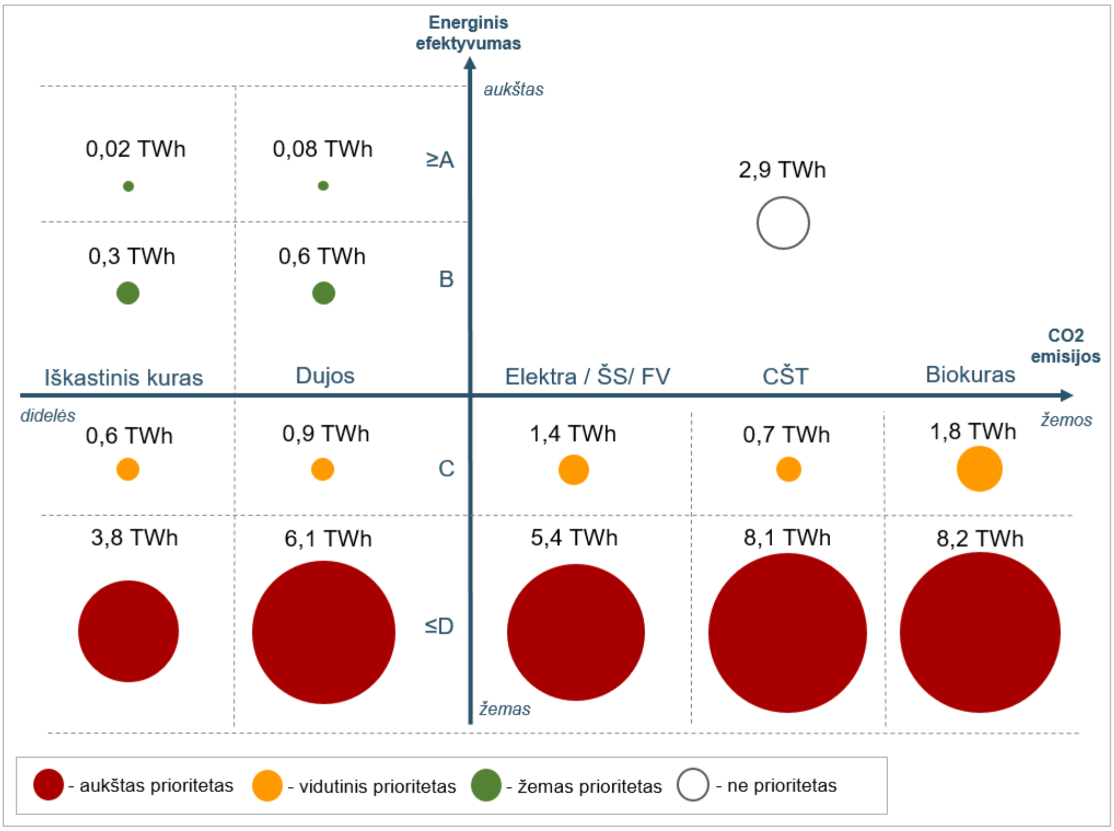
- To ensure implementation of the one-stop shop. The best preconditions for the implementation of one-stop shop functions are the municipalities which have the most reliable data on buildings and the building owners are in constant contact with the municipality on other issues.
- To establish a centre of excellence. This establishment should centralise good practice, standardise processes and provide methodological and advisory assistance to municipalities and renovation administrators.
- To establish a maintenance mechanism. A mechanism for the application of external control measures should be established at each stage of the implementation of the renovation. This would increase the confidence of building owners and reduce the risk of renovation delays.

Priority axes for implementing the renovation strategy

The LTRS covers a period of 30 years and will require significant resources, so to implement the LTRS in a systematic, coherent and sustainable way, it is important to identify the priority segments of the building stock, to thoughtfully plan the measures necessary for their transformation and to allocate the resources needed for their implementation. Both the LTRS indicators and the renovation measures used to achieve them can be divided into two main groups:

- improving energy efficiency;
- increasing the use of RES (reduction of fossil fuels).

To identify priority groups of buildings, the building stock may be divided accordingly. The figure below shows the primary energy consumption of the building stock by energy efficiency (from the worst to the best) and by thermal energy source (from the highest to the lowest CO_2 emissions per unit of energy produced).



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Summarising the data presented in the figure above, it is possible to identify the priority groups of the building stock.

High priority:

- Low energy efficiency buildings (EPC ≤ D) using fossil fuels (9.9 TWh), which are subject to both the EE and RES measures.
- Low energy efficiency buildings not using fossil fuels[2] (21.7 TWh), which are subject to EE measures.

Medium priority:

- Medium energy efficiency buildings (EPC C) using fossil fuels (1.5 TWh), which are subject to both EE and RES measures.
- Medium energy efficiency buildings (3.9 TWh) not using fossil fuels, which are subject to EE measures.

Low priority:

- High energy efficiency buildings (EPC ≥ B) using fossil fuels (1 TWh), which are subject to both EE and RES measures.

The priority axes identified above should be reflected in the package of measures being prepared, providing for support measures targeted at the priority segments of the building stock, e.g. district renovation for low-energy multi-apartment buildings, RES measures to replace individual sources of production using fossil fuels, etc. The implementation of specific RES measures may be carried out by choosing various RES sources, such as the installation of heat pumps and/or photovoltaic solar collectors, the production of electricity from wind or hydroelectric power plants, the production of biofuels, the production of heat from water-heating solar collectors, connection to DH grids, the purchase and consumption of energy from remote solar, wind and hydroelectric power plants.

[2] The LTRS scope estimates that the electricity and DH sectors will evolve towards fossil fuel divestment (based on the NEIS)

It is estimated that the DH and electricity sectors will transform purposefully in the direction of fossil fuel abandonment during the implementation of the LTRS, therefore replacing them with alternative RES measures would not be economically rational and would not be encouraged. This provision should be reassessed periodically (by updating the LTRS), considering the actual results of the envisaged sectoral transformation.

The priority axes of the LTRS described above comply with the provisions of the EPBD and other EU strategic documents, which provide that:

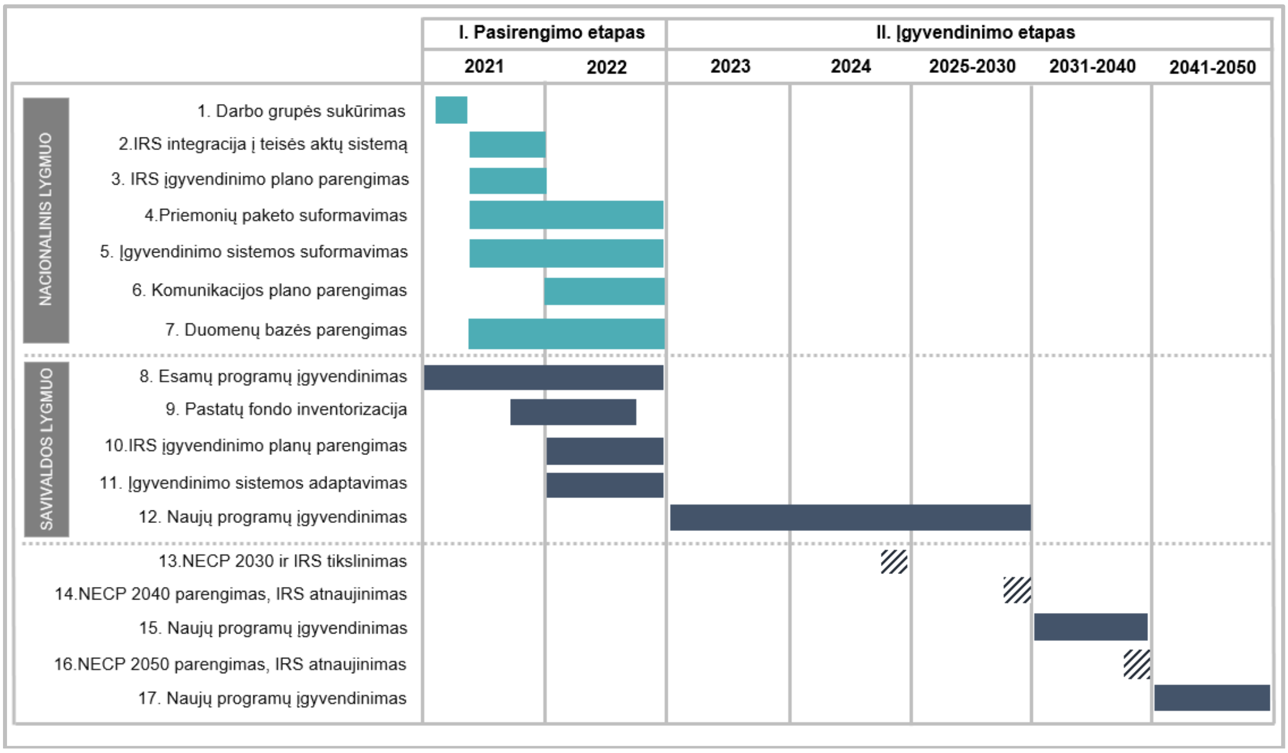
- In the renovation of the building stock, priority is given to 'efficient energy use, applying the Energy Efficiency First principle, and considering the use of RES'.
- Great attention must be paid to buildings with the lowest energy performance.
- Financial measures to improve energy efficiency in the renovation of buildings should be linked to the target or achieved energy savings.

Roadmap for implementing the renovation strategy

The period of implementation of the LTRS from 2021 to 2050 is divided into two main stages:

- I. Preparatory stage (2021–2022).
- II. Implementation stage (2023–2050).

The figure below provides a summary of the main steps in the implementation of the LTRS, and roadmap. It is important to note that during the implementation of the LTRS, it is planned that the LTRS will be updated two times in principle (when drafting NECP 2040 and NECP 2050), and revised three times (when updating NECP 2030, NECP 2040, and NECP 2050, in the mid-implementation period).



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

A description of the main steps in the implementation of the LTRS is provided below.

1. Creation of a working group

The establishment of an organisational structure responsible for the implementation of the LTRS, such as an interinstitutional working group (committee), is a first step towards the implementation of project management principles in line with good practice in the LTRS. The project manager would implement the functions of the LTRS project manager, i.e. within the limits of its mandate, would be responsible for the identification, review and updating of LTRS indicators, the compatibility of the LTRS with other energy efficiency and RES promotion policy measures, energy sector planning, etc.

2. Integration of the LTRS into the legislative framework

The implementation process of the LTRS is highly fragmented, with many involved parties with different interests, acting in accordance with different legislation, financing their contribution to the implementation of the LTRS from different sources of funding, etc. Accordingly, to avoid legislative obstacles to the implementation of the LTRS, the project manager should initiate the integration of the LTRS into the legislative framework.

3. Development of the LTRS implementation plan

In accordance with the strategic planning practices and requirements, long-term LTRS indicators and priorities are elaborated in a short- to medium-term planning document (e.g. the LTRS implementation plan or the interinstitutional operational plan for the implementation of the LTRS), covering all the institutions concerned and setting out the indicators, tasks, measures (see Stage 4) and appropriations for the implementation of the LTRS for the period 2021–2030[3].

4. Developing a package of measures

A package of support measures corresponding to the targeted LTRS indicators is formed, which would completely replace the existing support measures from 2023 and would ensure:

- proper implementation of the LTRS priorities;
- the application of balanced complex motivational measures (both incentives and penalties) and maximisation of the pace and benefits of renovation;
- the adequacy and availability of funding sources and mechanisms;
- setting minimum requirements for energy performance (energy consumption) after renovation;

5. Developing an implementation framework

To ensure the smooth implementation of the renovation process and to enable the achievement of a quality renovation result, the project manager should develop the implementation framework of the LTRS. Key elements of the system should include a competence centre, a quality control mechanism and a monitoring system.

6. Preparation of the communication plan

The project manager should develop an LTRS communication strategy covering both long-term renovation rates and specific renovation measures. The authority responsible for implementing the communication should be designated.

7. Preparation of the database

To address the data gap, the building stock database should be developed, a long-term administrator of the database should be appointed and its funding source secured. The database should be built in the following stages:

1. Requirements for data collection in municipalities are established;
2. Data collection takes place in municipalities (see Stage 9) and a methodology for data processing and comparison with external sources has been developed.
3. The data provided by the municipalities are consolidated by filling in the database and updating the LTRS indicators (see Stage 13).

[3] Pending preparation of NECP 2040 and update of the LTRS (see Stage 14)

4. A process for collecting data on the renovation carried out shall be established, during which the existing data of the building stock shall be supplemented.

8. Implementation of existing programmes

The implementation of the existing support programmes must be ensured during the preparatory stage. Once the package of new support measures has been developed (see Stage 4), the implementation stage of the LTRS, and the implementation of the new support measures starts (see Stage 12).

9. Inventory of building stock

Based on the developed data collection instructions and the required data structure (see Stage 7), municipalities should collect information on the existing building stock: the number and area of buildings used (heated), their energy production sources and energy consumption. The information collected should be made available in a centralised database and used for the development of IRS implementation plans in municipalities (see Stage 10).

10. Development of the LTRS implementation plans

Based on the indicators established by the LTRS and the information collected on the municipal building stock (see Stage 9), municipalities must prepare municipal LTRS implementation plans that include the planned indicators at the municipal level as well as integration with other planning documents.

11. Adapting the implementation framework

Municipalities should adapt the support measures (see Stage 4) and the national implementation framework for the LTRS (see Stage 5) at local level, ensuring the implementation of the one-stop shop.

12. Implementation of the new programme package

Once the package of new support measures has been developed (see Stage 4), the implementation stage of the LTRS, and the implementation of the new support measures starts.

13. Update of the NECP and the LTRS

The LTRS is an integrated part of the NECP in implementing the requirements of the EU Directives. Considering the requirements of the NECP, the LTRS must be updated and submitted to the European Commission together with the updated NECP by June 2024.

14. Preparation of the NECP 2040 and update of the LTRS

The LTRS is an integrated part of the NECP in implementing the requirements of the EU Directives. Considering the requirements of the NECP, the implementation of the new period (2031–2040) the NECP should be drawn up and submitted to the European Commission by 1 January 2029.

15. Implementation of new programmes

Once the package of new support measures has been developed (see Stage 14), the implementation phase of the LTRS, and the implementation of the new support measures continues.

16. Preparation of the NECP 2050 and update of the LTRS

The LTRS is an integrated part of the NECP in implementing the requirements of the EU directives. Considering the current requirements of the NECP, the implementation of the new period (2041–2050) the NECP should be drawn up and submitted to the European Commission by 1 January 2039.

17. Implementation of new programmes

Once the package of new support measures has been developed (see Stage 16), the implementation stage of the LTRS, and the implementation of the new support measures continues.

INTRODUCTION

Directive (EU) 2018/844 of the European Parliament and of the Council of 30 May 2018 (the 'Amending Directive') amending Directive 2010/31/ES on the energy performance of buildings (the 'EPBD'), and Directive 2012/27/EU on energy efficiency (the 'EED') requires Lithuania to establish a long-term renovation strategy to support the renovation of the national stock of residential and non-residential buildings, both public and private, into a highly energy efficient and decarbonised building stock by 2050, facilitating the cost-effective transformation of existing buildings into nearly zero-energy buildings.

According to Regulation (EU) 2018/1999 of the European Parliament and of the Council of 11 December 2018 on the Governance of the Energy Union and Climate Action, amending Regulations (EC) No 663/2009 and (EC) No 715/2009 of the European Parliament and of the Council, Directives 94/22/EC, 98/70/EC, 2009/31/EC, 2009/73/EC, 2010/31/EU, 2012/27/EU and 2013/30/EU of the European Parliament and of the Council, Council Directives 2009/119/EC and (EU) 2015/652 and repealing Regulation (EU) No 525/2013 of the European Parliament and of the Council, each Member State's long-term renovation strategy shall be submitted to the Commission as part of its final integrated national energy and climate plan referred to in Article 3 of Regulation (EU) 2018/1999 of the European Parliament and of the Council.

In its long-term renovation strategy, each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80–95% compared to 1990, to ensure a highly energy efficient and decarbonised national building stock and to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU.

1. OVERVIEW OF THE NATIONAL BUILDING STOCK

Article 2a(1)(a) of the EPBD provides that each LTRS shall encompass 'an overview of the national building stock, based, as appropriate, on statistical sampling and expected share of renovated buildings in 2020'.

The expected share of renovated buildings may be expressed in various ways, for example: (a) as a percentage (%); (b) as an absolute number; or (c) in m^2 of renovated space per type of building.

Renovation depth (e.g. 'light', 'medium' and 'deep') could also be used for greater accuracy. Another possible indicator is the conversion of buildings into NZEBs[1]. More generally, 'deep renovation' should result in both energy and greenhouse gas efficiency.

The 'expected share' is not intended to be a binding target, but rather a figure that realistically represents the likely rate of completed building renovation in 2020. Member States can also mention the expected share of completed renovation for 2030, 2040 and 2050, in line with the requirement to provide indicative milestones for those years.

[1] – The following renovation depths have been developed in the context of the EU Building Stock Observatory based on primary energy savings: — light (less than 30%); — medium (between 30% and 60%); and — deep (over 60%). NZEB renovations are not defined in terms of a specific primary energy saving threshold, but

This chapter presents the results of the overview of the national building stock carried out:

- Structure of the building stock (Chapter 1.1).
- Energy consumption of the building stock (Chapter 1.2).
- CO_2 emissions of the building stock (Chapter 1.3).
- Specific segments of the building stock (Chapter 1.4).
- Essential observations of the section (Chapter 1.5).

1.1. STRUCTURE OF THE BUILDING STOCK

This chapter provides an overview of the building stock to identify the most significant segments of the building stock and their essential features in the context of the LTRS.

1.1.1. Building stock by group and subgroup

According to the data of the RPR as of 31 December 2019, 2.6 million buildings with a total area of 235.3 million m^2 were registered in Lithuania. The data are grouped into the main building groups and subgroups indicated in the table below.

Table 1. National building stock by building groups and subgroups

Group of buildings	Subgroup of buildings	Number, units	Total area, m^2	Area, %
Residential buildings	Private houses	529 492	69 540 001	30%
	Multi-apartment buildings (< 1 000 m^2)	24 113	9 334 072	4%
	Multi-apartment buildings (1 000–5 000 m^2)	15 072	37 805 494	16%
	Multi-apartment buildings (> 5 000 m$^{2)}$	1 836	12 324,006	5%
Non-residential buildings	Industrial facilities	48 775	35 489 710	15%
	Administrative facilities	10 377	10 096 910	4%
	Educational facilities	4 715	8 503 112	4%
	Trading facilities	8 760	7 064 489	3%
	Health care facilities	1 839	2 951 779	1%
	Accommodation facilities	6 900	2 496 666	1%
	Cultural facilities	2 341	2 279 194	1%
	Service facilities	5 059	2 199 200	1%
	Other non-residential buildings	2 004	1 589 089	1%
Non-LTRS facilities	Garages	22 568	9 073 844	4%
	Religious facilities	1 764	633 023	0%
	Non-heated, temporary, etc. building	1 893 894	23 884 175	10%
TOTAL		**2 579 509**	**235 264 764**	100%

Source: RPR data (31-12-2019)

The table below shows the correlation between the above groups of residential and non-residential buildings and the RPR attributes.

Table 2. Relationship between residential and non-residential building groups and RPR attributes

Study (aggregated)	Study	RPR
Private houses	Private houses	Residential facilities (single- and double-apartment houses)
Multi-apartment buildings	Multi-apartment buildings	Residential facilities (three- and multi-apartment houses) Residential facilities (for various social groups)
Industrial facilities	Industrial facilities	Manufacturing and industrial, storage facilities
Other non-residential buildings	Administrative facilities	Administrative facilities
	Educational facilities	Educational facilities
	Trading facilities	Trading facilities
	Health care facilities	Health care facilities
	Accommodation facilities	Hotels Recreation facilities
	Cultural facilities	Cultural facilities
	Service facilities	Catering, services facilities
	Other non-residential buildings	Transport, sports, special-purpose facilities
Non-LTRS facilities	Garages	Garages
	Religious facilities	Religious facilities
	Non-heated, temporary, etc. building	Other uses (not mentioned above)

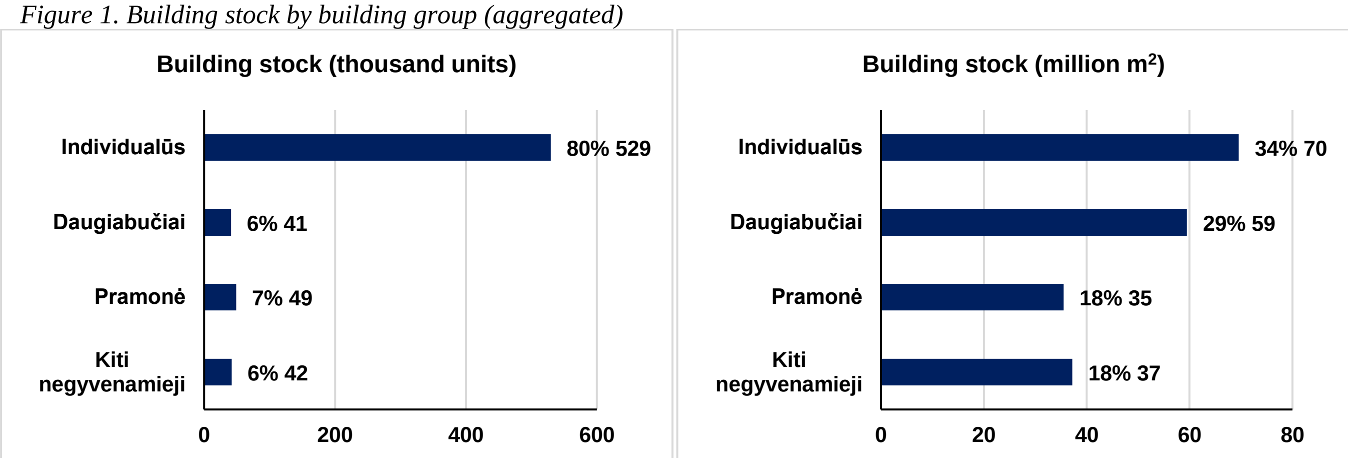
Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The 'Non-LTRS facilities' group includes buildings that are not subject to the energy performance requirements under the building code[4]:

- Buildings for religious use: houses of worship and other religious facilities. Most (~80%) of religious facilities were constructed before 1940 and are included in the list of non-movable heritage buildings.
- Garage and outbuildings, etc., classified as low-energy production and industrial buildings, storage buildings and/or buildings where the temperature during the heating season is not higher than 10°C.
- Buildings with a total area of no more than 50 m2.

The building stock is then considered after the elimination of the 'Non-LTRS facilities' group of buildings (hereafter referred to as the 'building stock'). Aggregated building stock data by building groups and subgroups are presented in the figure below.

Figure 1. Building stock by building group (aggregated)



Source: RPR data (31-12-2019)

[4] STR 2.01.02:2016 'Design and certification of energy performance of buildings'

To summarise the above data, it can be observed that:

- the average building areas vary significantly: ~130 m^2 for private houses, ~1 450 m^2 for multi-apartment buildings, ~700 m^2 for industrial buildings, and ~900 m^2 for other non-residential buildings;
- residential buildings account for 2/3 (64%) of the total surface of the building stock. This is the most significant building segment in terms of building area;
- in the residential segment, apartment blocks and detached houses are distributed in similar proportions in terms of the area (29% and 34% of the total surface of the building stock). However, in terms of the number of buildings, individual buildings account for as much as 80%, while multi-apartment buildings account for only 6% of the total number of buildings;
- Accordingly, to achieve economies of scale and faster renovation rates, multi-apartment buildings are a priority segment of the LTRS, accounting for only 6% of the total. In terms of the number of buildings, the share of the building stock by number of buildings, but as much as 29% by the area.

1.1.2. Building stock by use and year of construction

The tables below show the building stock by year of completion of construction, units and thousand m^2.

Table 3. Building stock by year of completion (units)

Group, subgroup	Year of construction								Total	Total (%)
	before 1900	1901–1960	1961–1992	1993–2005	2006–2013	2014–2016	2017–2018	2019		
1. Residential buildings	13 417	204 189	239 068	28 955	35 272	22 001	17 773	9 838	570 513	86%
1.1. Private houses	11 917	191 307	216 399	27 171	34 227	21 584	17 319	9 568	**529 492**	80%
1.2. Multi-apartment buildings	1 500	12 882	22 669	1 784	1 045	417	454	270	**41 021**	6%
2. Non-residential buildings	1 390	13 178	57 783	8 930	4 897	2 329	1 603	660	90 770	14%
2.1. Industrial buildings	498	5 907	34 521	4 101	2 064	904	612	168	**48 775**	7%
2.2. Administrative buildings	225	2 122	6 345	955	396	153	126	55	**10 377**	2%
2.3. Educational buildings	121	1 044	3 287	137	76	34	12	4	**4 715**	1%
2.4. Trading buildings	96	1 272	4 108	2 007	650	303	237	87	**8 760**	1%
2.5. Health care buildings	42	542	1 023	126	66	18	18	4	**1 839**	0.28 %
2.6. Accommodation buildings	44	458	3 462	610	1 076	591	412	247	**6 900**	1.04 %
2.7. Cultural facilities	221	753	1 199	80	41	40	7	0	**2 341**	0.35 %
2.8. Service facilities	78	717	2 802	653	365	216	153	75	**5 059**	0.77 %
2.9. Other buildings	65	363	1 036	261	163	70	26	20	**2 004**	0.30 %
Total	**14 807**	**217 367**	**296 851**	**37 885**	**40 169**	**24 330**	**19 376**	**10 498**	**661 283**	100%
Total (%)	2%	33%	45%	6%	6%	4%	3%	2%	100%	

Source: RPR data (31-12-2019)

Table 4. Building stock by year of completion (thousand m^2)

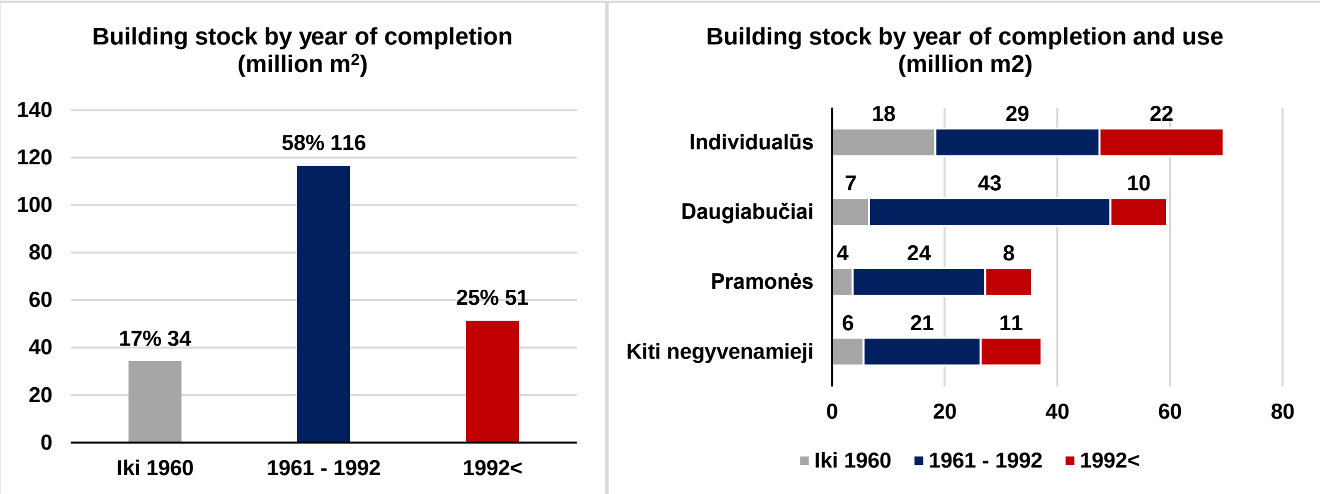
Group, subgroup	Year of construction								Total	Total, %
	before 1900	1901–1960	1961–1992	1993–2005	2006–2013	2014–2016	2017–2018	2019		
1. Residential buildings	1 765	23 105	72 038	11 067	10 461	4 841	3 768	1 958	129 004	64%
1.1. Private houses	1 212	17 095	29 160	6 628	7 231	3 912	2 861	1 441	**69 540**	34%
1.2. Multi-apartment buildings	553	6 010	42 878	4 439	3 230	929	907	517	**59 464**	29%
2. Non-residential buildings	840	8 384	44 337	7 405	6 477	2 360	1 954	913	72 670	36%
2.1. Industrial buildings	235	3 416	23 537	3 382	2 627	968	891	433	**35 490**	18%

2.2. Administrative buildings	169	1 554	5 706	924	844	351	332	217	**10 097**	5%
2.3. Educational buildings	118	1 257	6 367	386	220	125	16	14	**8 503**	4%
2.4. Trading buildings	47	495	2 375	1 627	1 631	491	316	83	**7 064**	4%
2.5. Health care buildings	27	467	1 973	218	178	50	37	2	**2 952**	1.46%
2.6. Accommodation buildings	40	261	987	257	424	207	206	116	**2 497**	1.24%
2.7. Cultural facilities	145	467	1 449	122	59	14	23	0	**2 279**	1.13%
2.8. Service facilities	31	227	1 231	291	203	87	83	45	**2 199**	1.09%
2.9. Other buildings	28	239	711	199	291	66	49	5	**1 589**	0.79%
Total	**2 605**	**31 489**	**116 375**	**18 472**	**16 938**	**7 201**	**5 722**	**2 872**	**201 674**	100%
Total (%)	1%	16%	58%	9%	8%	4%	3%	1%	100%	

Source: RPR data (31-12-2019)

Aggregated building stock data by year of completion are presented in the figure below.

Figure 2. Building stock by year of completion (aggregated)



Source: RPR data (31-12-2019)

To summarise the above data, it can be observed that:

- Majority of buildings by area (75%) were built in Lithuania before 1993. Insulation materials were not used for better thermal insulation of these buildings and only the specific thermal resistance of construction materials (such as bricks, blocks or slabs) solved the thermal resistance of the building. Moreover, a significant share of these buildings has not been renovated, nor have they been involved into the non-stock renovation programmes. As a result, a large part of the building stock is in poor technical condition (especially in the multi-apartment segment). Accordingly, this building segment is treated as a priority in the context of the LTRS.
- 58% of the surface of the building stock consists of buildings constructed between 1961 and 1992. Their architectural and structural diversity is unlikely to be great. Accordingly, there is potential for the implementation of repetitive (standard) renovation solutions, especially in the segment of multi-apartment buildings, where ~72% of buildings were constructed in 1961–1992.

1.1.3. Building stock by type of ownership

The tables below show the area of the building stock by type of ownership, in units and thousand m^2.

Table 5. Building stock by type of ownership (units)

Group	Ownership type					Total	Total (%)
	Private			Public			
	Owned by natural persons	Owned by legal entities	Mixed, other	State	Municipal		
1. Residential buildings	401 478	5 267	160 839	1 164	1 765	570 513	86%
1.1. Private houses	400 539	4 855	121 983	787	1 328	**529 492**	80%
1.2. Multi-apartment buildings	939	412	38 856	377	437	**41 021**	6%
2. Non-residential buildings	23 046	36 550	17 554	6 203	7 417	90 770	14%
2.1. Industrial buildings	12 216	24 120	9 169	2 159	1 111	**48 775**	7%
2.2. Administrative buildings	1 680	3 980	2 509	1 343	865	**10 377**	2%
2.3. Educational buildings	465	468	328	681	2 773	**4 715**	0.7%
2.4. Trading buildings	2 670	3 538	2 404	38	110	**8 760**	1.3%
2.5. Health care buildings	244	345	315	347	588	**1 839**	0.3%
2.6. Accommodation buildings	3 410	1 715	1 371	279	125	**6 900**	1.0%
2.7. Cultural facilities	286	330	353	267	1 105	**2 341**	0.4%
2.8. Service facilities	1 883	1 664	906	263	343	**5 059**	0.8%
2.9. Other buildings	192	390	199	826	397	**2 004**	0.3%
Total	**424 524**	**41 817**	**178 393**	**7 367**	**9 182**	**661 283**	100%
Total (%)	64%	6%	27%	1%	1%	100%	

Source: RPR data (31-12-2019)

Table 6. Building stock by type of ownership (thousand m^2)

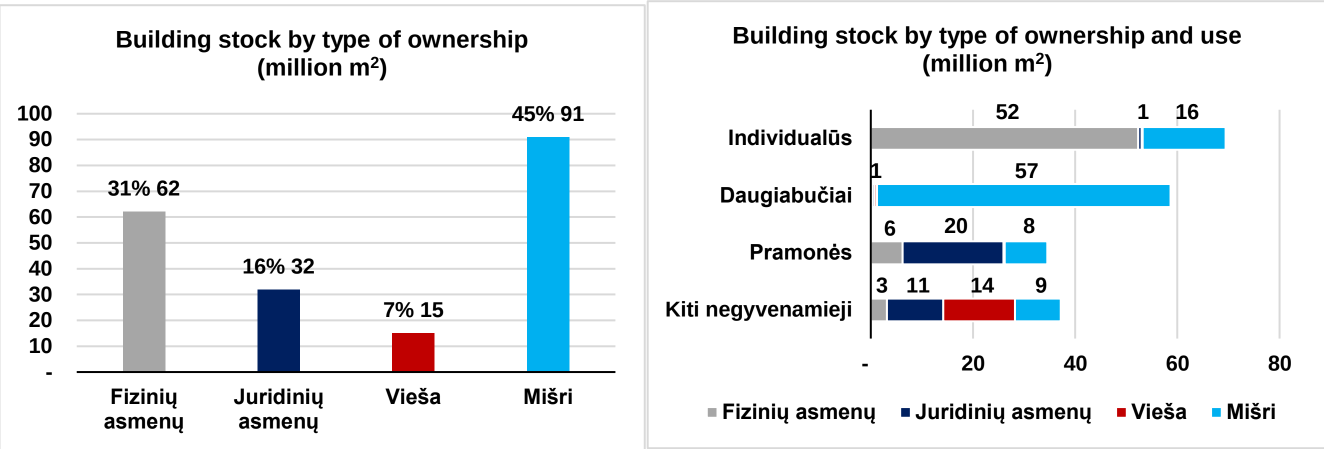
Group	Ownership type					Total	Total (%)
	Private			Public			
	Owned by natural persons	Owned by legal entities	Mixed, other	State	Municipal		
1. Residential buildings	52 651	1 196	73 652	915	590	**129 004**	64%
1.1. Private houses	52 331	722	16 225	106	157	**69 540**	34%
1.2. Multi-apartment buildings	320	474	57 428	809	433	**59 464**	29%
2. Non-residential buildings	9 389	30 732	17 216	6 476	8 857	**72 670**	36%
2.1. Industrial buildings	6 248	19 690	8 280	975	296	**35 490**	18%
2.2. Administrative buildings	837	3 832	3 460	1 449	519	**10 097**	5%
2.3. Educational buildings	269	794	477	1 822	5 142	**8 503**	4%
2.4. Trading buildings	676	3 643	2 651	8	86	**7 064**	4%
2.5. Health care buildings	99	451	329	938	1 134	**2 952**	1.5%
2.6. Accommodation buildings	544	835	967	81	69	**2 497**	1.2%
2.7. Cultural facilities	132	306	314	450	1 078	**2 279**	1.1%
2.8. Service facilities	496	905	506	184	107	**2 199**	1.1%
2.9. Other buildings	87 304	276 569	231 536	568 815	424 865	**1 589**	0.8%
Total	**62 040**	**31 928**	**90 868**	**7 391**	**9 446**	**201 674**	100%
Total (%)	31%	16%	45%	4%	5%	100%	

Source: RPR data (31-12-2019)

The RPR attribute 'Mixed ownership' is defined as the common ownership of natural persons and legal entities, the state and municipalities, the state, natural persons and legal entities, municipalities, natural persons and legal entities. This attribute is also assigned to buildings for which no property rights have been registered.

Aggregated building stock data by type of ownership are presented in the figure below.

Figure 3. Building stock by type of ownership (aggregated)



Source: RPR data (31-12-2019)

To summarise the above data presented in the tables it can be observed that:

- Almost half (45%) of the building stock consists of mixed ownership, i.e. a situation where more than one person is the owner of a building (e.g. In 98% of the cases, the ownership of multi-apartment buildings by area is mixed). Similarly, mixed ownership may reflect a situation where a building is owned not only by more than one person but also by different persons according to the type of ownership, e.g. a part of a building is owned by natural persons, a part is owned by public or legal persons. In both cases, this means a significantly more complex process of implementation of the renovation than in the case of a single building owner. The dilemma of incentives for different owners/users is discussed in more detail in Chapter 3.2.2.
- 31% of the surface of the building stock are owned by natural persons, mostly consisting of private houses. Although there are more such objects and their architectural diversity is likely to be greater (a factor slowing down renovation), renovation of such buildings could be faster due to faster and simpler decision-making and a stronger interest of owners in taking care of personal property.
- 16% of the surface of the building stock consists of the property of legal persons, which consists mainly of industrial, administrative, and commercial facilities. The decisions of legal entities depend mainly on the payback period of the investment, which is not attractive at the current energy price level.
- 7% of the surface of the building stock consists of public (municipal and state) property. This segment of the building stock can be controlled from a public perspective. Accordingly, it is public buildings that should serve as a good example of successful renovation.

1.1.4. Building stock by wall materials

The tables below show the distribution of the building stock by the wall materials.

Table 7. Building stock by wall materials (units)

Group	Wall materials						Total	Total (%)
	Bricks and blocks	**Reinforced concrete panels**	**Monolithic concrete**	**Timber**	**Façade systems**	**Other**		
1. Residential buildings	257 320	12 730	3 677	239 104	225	57 457	**570 513**	86%
1.1. Private houses	230 651	6 073	3 306	233 226	214	56 022	**529 492**	80%
1.2. Multi-apartment buildings	26 669	6 657	371	5 878	11	1 435	**41 021**	6%
2. Non-residential buildings	59 894	7 976	908	4 113	8 488	9 391	**90 770**	14%
2.1. Industrial buildings	33 029	4 779	494	708	6 051	3 714	**48 775**	7%
2.2. Administrative buildings	8 289	814	103	398	313	460	**10 377**	2%
2.3. Educational buildings	3 057	1 039	41	403	40	135	**4 715**	0.7%
2.4. Trading buildings	5 126	768	64	433	1 338	1 031	**8 760**	1.3%
2.5. Health care buildings	1 477	97	9	148	5	103	**1 839**	0.3%
2.6. Cultural facilities	2 420	36	62	1 175	64	3 143	**6 900**	1.0%
2.7. Accommodation buildings	1 558	119	15	428	9	212	**2 341**	0.4%
2.8. Service facilities	3 562	199	27	394	426	451	**5 059**	0.8%
2.9. Other buildings	1 376	125	93	26	242	142	**2 004**	0.3%
Total	**317 214**	**20 706**	**4 585**	**243 217**	**8 713**	**66 848**	**661 283**	100%
Total (%)	48%	3%	1%	37%	1%	10%	100%	

Source: RPR data (31-12-2019)

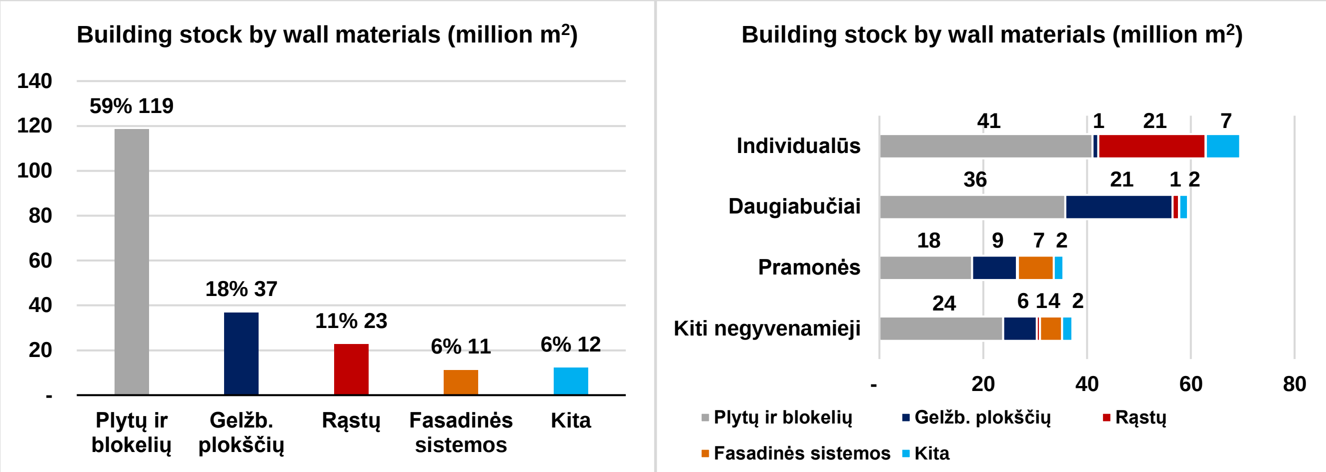
Table 8. Building stock by wall materials (thousand m^2)

Group	Wall materials						Total	Total (%)
	Bricks and blocks	**Reinforced concrete panels**	**Monolithic concrete**	**Timber**	**Façade systems**	**Other**		
1. Residential buildings	**76 880**	**21 792**	**1 745**	**21 938**	**50**	**6 599**	**129 004**	**64%**
1.1. Private houses	41 055	1 137	484	20 666	25	6 173	**69 540**	34%
1.2. Multi-apartment buildings	35 825	20 655	1 261	1 272	24	426	**59 464**	29%
2. Non-residential buildings	**41 718**	**15 098**	**1 840**	**790**	**11 200**	**2 023**	**72 670**	**36%**
2.1. Industrial buildings	17 890	8 618	557	159	6 932	1 334	**35 490**	18%
2.2. Administrative buildings	6 786	1 695	752	79	707	78	**10 097**	5%
2.3. Educational buildings	5 251	2 817	112	144	121	57	**8 503**	4.2%
2.4. Trading buildings	3 221	833	95	69	2 716	130	**7 064**	3.5%
2.5. Health care buildings	2 439	431	16	40	6	19	**2 952**	1.5%
2.6. Cultural facilities	1 825	97	140	144	62	228	**2 497**	1.2%
2.7. Accommodation buildings	1 795	255	41	95	23	71	**2 279**	1.1%
2.8. Service facilities	1 493	215	63	57	302	68	**2 199**	1.1%
2.9. Other buildings	1 018	136	63	4	330	38	**1 589**	0.8%
Total	**118 598**	**36 890**	**3 586**	**22 728**	**11 250**	**8 622**	**201 674**	100%
Total (%)	59%	18%	2%	11%	6%	4%	100%	

Source: RPR data (31-12-2019)

Aggregated building stock data by wall materials are presented in the figure below.

Figure 4. Building stock by wall materials (aggregated)



Source: RPR data (31-12-2019)

To summarise the above data, it can be observed that:

- 79% of the total surface of the building stock consists of buildings with retaining walls consisting of bricks and blocks, reinforced concrete slabs and monolithic concrete (the monolithic concrete walls in the figure above belong to the group 'Other').
- 11% of the total surface of the building stock consists of timber buildings, the majority of which (91%) are private houses. 72% of the private houses were built before 1960, and 23% were built between 1960 and 1990. There is no reliable data on the proportion of these buildings that are permanently occupied and/or regularly heated.
- 6% of the total surface of the building stock consists of buildings with façade systems (metal in frame, glass in frame). 86% of all façade system buildings consist of two main building applications: industrial and commercial. In the context of the LTRS, it is important to note that the renovation of façade systems requires a significantly higher investment than for other load-bearing walls, as the entire wall structure must be replaced. Also, some façade systems may be difficult to replace due to technical feasibility. The share of buildings that will not be renovated has been considered in the forecast.
- 4% of the total surface of the building stock is assigned to the 'Other' type of walls (in the figure above, the group 'Other' also includes buildings with 2% of monolithic concrete walls), i.e. in the database of the Centre of Registers, buildings were assigned a wall type of straw, clay, wood, wooden frame, tin, slate or other materials. Most (77%) of this type of buildings are residential buildings, of which 94% are individual houses. It is likely that most of these buildings will not participate in the renovation, as a significant proportion of them are not permanently occupied or regularly heated, and the technical options for renovation are very limited. Of the 'Other' type of buildings, only wooden frame buildings could be retrofitted using standard renovation measures. The share of buildings that will not be renovated has been considered in the forecast.

1.1.5. Building stock by type of heating

The following is a section of the building stock according to the fact of connection to the district heating supply (the 'DH') system, units, and thousand m².

Table 9. Building stock by type of heating – connected or not connected to DH (units)

Group	DH		Total	Total (%)
	Connected	Not connected		
1. Residential buildings	26 192	544 321	570 513	86%
1.1. Private houses	7 192	522 300	**529 492**	80%
1.2. Multi-apartment buildings	19 000	22 021	**41 021**	6%
2. Non-residential buildings	15 010	75 760	90 770	14%
2.1. Industrial buildings	3 985	44 790	**48 775**	7%
2.2. Administrative buildings	3 966	6 411	**10 377**	2%
2.3. Educational buildings	2 217	2 498	**4 715**	1%
2.4. Trading buildings	1 711	7 049	**8 760**	1%
2.5. Health care buildings	816	1 023	**1 839**	0.28%
2.6. Cultural facilities	344	6 556	**6 900**	1.04%
2.7. Accommodation buildings	664	1 677	**2 341**	0.35%
2.8. Service facilities	830	4 229	**5 059**	0.77%
2.9. Other buildings	477	1 527	**2 004**	0.30%
Total	**41 202**	**620 081**	**661 283**	100%
Total (%)	6%	94%	100%	

Source: RPR data (31-12-2019)

Table 10. Building stock by type of heating – connected or not connected to DH (thousand m²)

Group	DH		Total	Total (%)
	Connected	Not connected		
1. Residential buildings	45 653	83 351	129 004	64%
1.1. Private houses	1 388	68 152	**69 540**	34%
1.2. Multi-apartment buildings	44 264	15 199	**59 464**	29%
2. Non-residential buildings	27 653	45 018	72 670	36%
2.1. Industrial buildings	7 293	28 197	**35 490**	18%
2.2. Administrative buildings	5 812	4 285	**10 097**	5%
2.3. Educational buildings	5 762	2 741	**8 503**	4%
2.4. Trading buildings	3 022	4 042	**7 064**	4%
2.5. Health care buildings	2 056	896	**2 952**	1.46%
2.6. Cultural facilities	774	1 723	**2 497**	1.24%
2.7. Accommodation buildings	1 319	960	**2 279**	1.13%
2.8. Service facilities	727	1 473	**2 199**	1.09%
2.9. Other buildings	888	701	**1 589**	0.79%
Total	**73 305**	**128 369**	**201 674**	100%
Total (%)	36%	64%	100%	

Source: RPR data (31-12-2019)

To verify the accuracy of the data, the data were compared with the information published by the Lithuanian District Heating Association (the 'LDHA'). The tables below show a comparison of the data.

Table 11. Building stock by type of heating – connected to DH (units and thousand m²)

Group	LDHA data		RPR data		Difference	
	Number	Heated area	Number	Heated area	Number	Heated area
Private houses	2 104	281	7 192	962	-242%	-242%
Multi-apartment buildings	18 426	37 206	19 000	35 561	-3%	4%
Other non-residential buildings	7 543	15 761	15 010	27 198	-99%	-73%
Total	28 073	53 248	41 202	63 721	171%	142%

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

There is a significant difference between the LDHA and RPR data:

- according to the RPR data, ~3.5 times the surface of private residential houses is connected to the DH;
- according to the RPR data, ~3.75 times the surface of other non-residential buildings is connected to the DH;
- the data of multi-apartment buildings do not differ significantly.

To summarise the above data presented in the table, it can be observed that:

- ¼ (26%) of the total surface of the building stock is connected to the district heating systems. Thus, although district heating is an important component of energy efficiency, it is not dominant.
- 74% of the surface of multi-apartment buildings (or 46% according to the number of multi-apartment buildings) is connected to the DH systems (which accounts for 60.4% of the total surface of the building stock connected to the DH);
- only 2% of private houses (or 1.3% in terms of area) are connected to DH systems (17.5% of the total number of buildings connected to DH and only 1.9% in terms of area);
- accordingly, the RES energy targets set in the NECP will not have a significant impact on the overall building stock through the decarbonisation of the DH (which is currently at an advanced stage of development and leadership at EU level).

1.1.6. Building stock by energy performance class

Energy performance class (EPC) of buildings is an essential source of information for the assessment of energy consumption of buildings.

Buildings with an energy performance certificate

Information on energy performance certificates issued is collected in the register[5] administered by Construction Production Certification Centre, State enterprise (the ‘SPSC Register’). The RPR collects information (attribute) on the energy performance class of buildings.

To summarise the above data, it can be observed that:

- Most (83%) of buildings in the building stock do not have an EPC attribute in the RPR;
- administrative and treatment buildings stand out from the buildings, almost half of which have energy performance certificates.

Table 12. Buildings with an energy performance certificate (units)

Group	Total buildings	Certified					Certified, %
		≤D	C	B	≥A	Total	
1. Residential buildings	**570 513**	**51 177**	**18 975**	**27 076**	**3 124**	**100 352**	**18%**
1.1. Private houses	**529 492**	44 515	16 642	25 237	2 847	89 241	17%
1.2. Multi-apartment buildings	**41 021**	6 662	2 333	1 839	277	11 111	27%
2. Non-residential buildings	**90 770**	**8 214**	**2 792**	**3 044**	**425**	**14 475**	**16%**
2.1. Industrial buildings	**48 775**	1 487	462	815	114	2 878	6%
2.2. Administrative buildings	**10 377**	3 643	671	610	81	5 005	48%
2.3. Educational buildings	**4 715**	648	549	275	22	1 494	32%
2.4. Trading buildings	**8 760**	829	271	481	95	1 676	19%
2.5. Health care buildings	**1 839**	440	204	234	8	886	48%
2.6. Cultural facilities	**6 900**	205	95	94	4	398	6%

[5] https://www.spsc.lt/cms/index.php?option=com_wrapper&view=wrapper&Itemid=288&lang=lt

2.7. Accommodation buildings	**2 341**	306	297	292	41	936	40%
2.8. Service facilities	**5 059**	453	129	130	41	753	15%
2.9. Other buildings	**2 004**	203	114	113	19	449	22%
Total SPSC	**661 283**	**59 391**	**21 767**	**30 120**	**3 549**	**114 827**	17%
Total RPR	**661 283**	**52 855**	**21 086**	**28 858**	**3 254**	**106 053**	16%

Source: SPSC Register, RPR.

Attribution of the energy performance attribute

The energy performance class attribute is necessary to determine the calculated primary energy consumption and therefore, for buildings without this characteristic, it has been assigned considering the construction year of the building by assigning the EPC for most of buildings certified for that construction year (see the table below):

Table 13. Attribution of the energy performance class by year of construction

No	*Year of construction*	*Energy performance class attributed*
1.	*up to 1900*	*≤D*
2.	*1901–1960*	*≤D*
3.	*1961–1992*	*≤D*
4.	*1993–2005*	*≤D*
5.	*2006–2013*	*C*
6.	*2014–2016*	*B*
7.	*2017–2018*	*B*
8.	*2019*	*A*

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

In the tables below, building stock data by energy performance class are presented.

Table 14. Building stock by energy performance class (units)

Group	**Energy performance class**						**Total**	**Total (%)**
	≤D	**C**	**B**	**A**	**A+**	**A++**		
1. Residential buildings	**342 160**	**176 116**	**43 305**	**8 077**	**837**	**19**	**570 513**	**86%**
1.1. Private houses	311 020	170 969	38 912	7 814	765	12	**529 492**	80%
1.2. Multi-apartment buildings	31 140	5 146	4 393	263	72	7	**41 021**	6%
2. Non-residential buildings	**78 175**	**6 059**	**5 689**	**713**	**125**	**9**	**90 770**	**14%**
2.1. Industrial buildings	44 552	2 091	1 920	178	29	5	**48 775**	7%
2.2. Administrative buildings	9 085	689	505	81	17	0	**10 377**	2%
2.3. Educational buildings	3 743	634	322	11	5	0	**4 715**	0.7%
2.4. Trading buildings	7 129	626	865	103	35	2	**8 760**	1.3%
2.5. Health care buildings	1 422	189	221	4	2	1	**1 839**	0.3%
2.6. Cultural facilities	4 474	1 066	1 095	246	18	1	**6 900**	1.0%
2.7. Accommodation buildings	2 029	155	147	7	3	0	**2 341**	0.4%
2.8. Service facilities	4 121	411	438	78	11	0	**5 059**	0.8%
2.9. Other buildings	1 620	198	176	5	5	0	**2 004**	0.3%
Total	**420 335**	**182 175**	**48 994**	**8 790**	**962**	**28**	**661 283**	100%
Total (%)	64%	28%	7%	1%	0%	0%	100%	

Source: Study authors

Table 15. Building stock by energy performance class (thousand m^2)

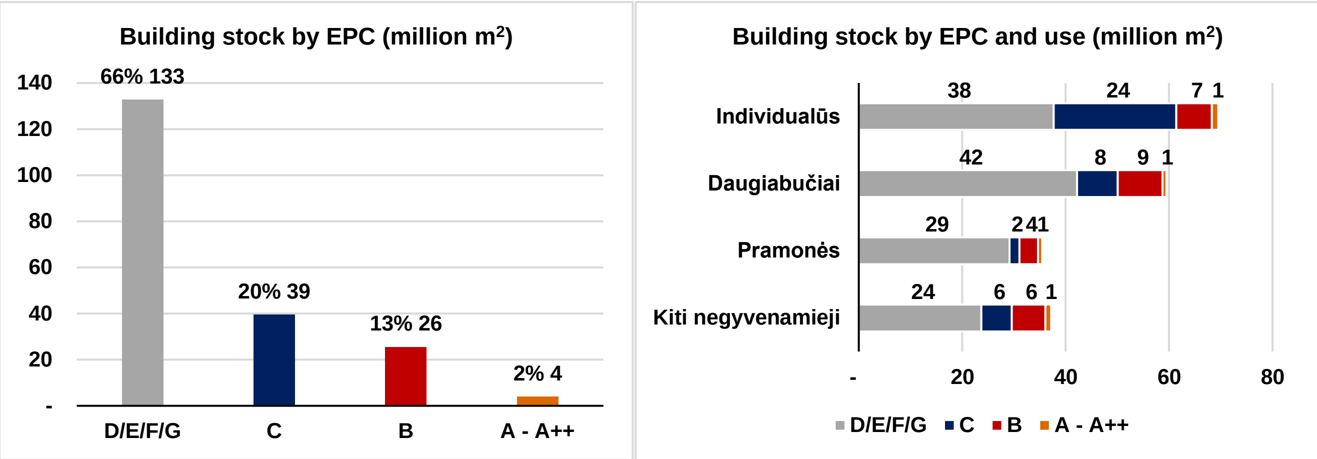
Group	**Energy performance class**						**Total**	**Total (%)**
	≤D	**C**	**B**	**A**	**A+**	**A++**		
1. Residential buildings	**79 926**	**31 571**	**15 501**	**1 698**	**283**	**24**	**129 004**	**64%**
1.1. Private houses	37 687	23 728	6 866	1 141	115	2	**69 540**	34%
1.2. Multi-apartment buildings	42 239	7 843	8 634	557	168	22	**59 464**	29%
2. Non-residential buildings	**52 809**	**7 895**	**10 024**	**1 345**	**501**	**96**	**72 670**	**36%**
2.1. Industrial buildings	29 135	1 962	3 534	574	192	93	**35 490**	18%
2.2. Administrative buildings	7 438	1 167	900	482	110	0	**10 097**	5%
2.3. Educational buildings	5 455	1 938	1 081	13	16	0	**8 503**	4.2%
2.4. Trading buildings	3 493	984	2 386	105	95	2	**7 064**	3.5%

2.5. Health care buildings	1 655	619	669	8	1	1	**2 952**	1.5%
2.6. Cultural facilities	1 262	483	595	108	46	1	**2 497**	1.2%
2.7. Accommodation buildings	1 819	258	188	10	4	0	**2 279**	1.1%
2.8. Service facilities	1 619	220	306	30	23	0	**2 199**	1.1%
2.9. Other buildings	932	264	365	15	14	0	**1 589**	0.8%
Total	**132 735**	**39 466**	**25 524**	**3 043**	**784**	**120**	**201 674**	100%
Total (%)	66%	20%	13%	2%	0%	0%	100%	

Source: Study authors

Aggregated building stock data by EPC are presented in the figure below.

Figure 5. Building stock by EPC (aggregated)



Source: RPR data (31-12-2019)

To summarise the above data, it can be observed that:

- 2/3 (66%) of the building stock surface consists of buildings in energy performance class lower than C. This segment is a priority in the context of the LTRS.
- 20% of the building stock surface consists of buildings in energy performance class C. This segment is not a priority in the short term, but it is significant enough and may play a role in the long term.
- 14% of the surface of the building stock consists of buildings with the EPC B or higher.

1.2. ENERGY CONSUMPTION OF THE BUILDING STOCK

This chapter provides an overview of the final and primary energy consumption of the building stock. Based on the EPBD, the energy performance of buildings is used to express the energy consumption of buildings, which is expressed 'by a numeric indicator of primary energy use in kWh/m^2 per year'[6].

The calculation of the energy (energy performance) of buildings is the basic stage of the renovation modelling and strategy development. Considering its results, at later stages the most cost-effective renovation methods are assessed (see Chapter 2), renovation indicators are set (see Chapter 5), and measures for the implementation of the renovation strategy are proposed (see Chapter 6).

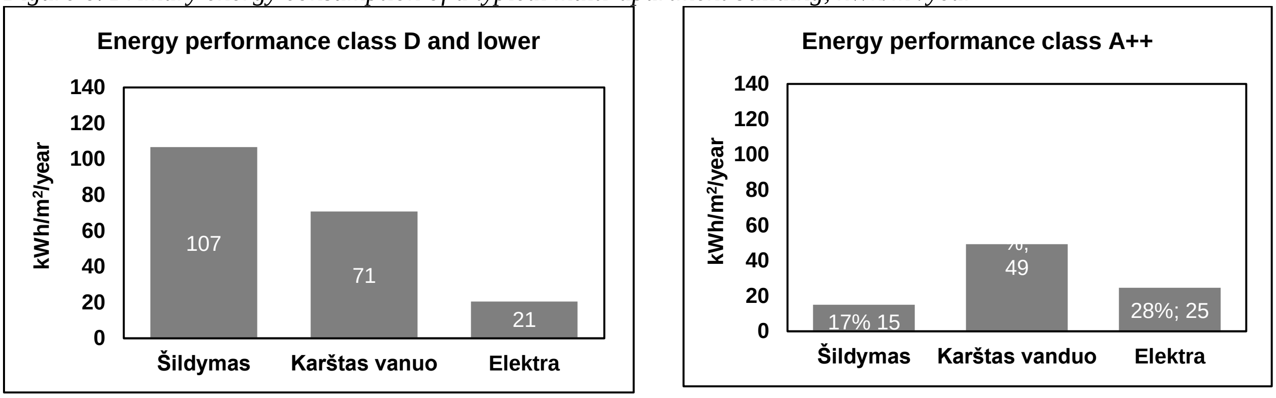
According to the EPBD, typical energy use in buildings includes energy used for space heating, space cooling, domestic hot water, ventilation, built-in lighting, and other technical building systems. According to the nature of the energy, the energy consumption of the building stock consists of three essential components:

- heat energy for heating the building;
- heat energy for hot water;
- electrical energy.

[6] Annex I (Point 1, second paragraph) to the EPBD

The EPBD provides that the LTRS may include actual or estimated energy consumption of the building stock (i.e. measured or calculated). The Strategy has assessed the calculated energy consumption of the building stock.

Figure 6. Primary energy consumption of a typical multi-apartment building, kWh/m²/year



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The primary energy consumption of a building significantly depends on the energy performance class of the building. The figure above shows an example of a typical apartment building (year of construction: 1961–1992, location: town, surface: 1 000–5 000 m², heat source for building heating and hot water preparation (DH) lowest and highest energy performance class comparison.

The greatest potential for primary energy savings, both in relative and absolute terms, is in heating consumption (the difference in consumption between the difference between the lowest and the highest energy efficiency class is ~86%) and hot water consumption (~31%).

The EPBD provides that when assessing the volume of energy consumption, it is appropriate to take into account the climatic zones of the country and their impact on energy consumption (to the extent applicable), see the section below.

1.2.1. Climatic conditions

Current situation

Lithuania is in a cool temperate climate zone with moderate warmth in summers and moderate cold in winters. The average temperature in July is about +17°C, while in winter it is about -5°C. The difference between the average temperatures is about 20°C. Although the whole territory of Lithuania falls within the cool temperate climate zone, the western part of the country is exposed to the Baltic Sea, where higher annual rainfall and wind speeds and higher average annual air temperature than in the rest of the country are recorded. The share of the building stock in the western part of the country accounts for about 11% of the total surface of the building stock (see the table below).

Table 16. Part of the building stock of Western Lithuania

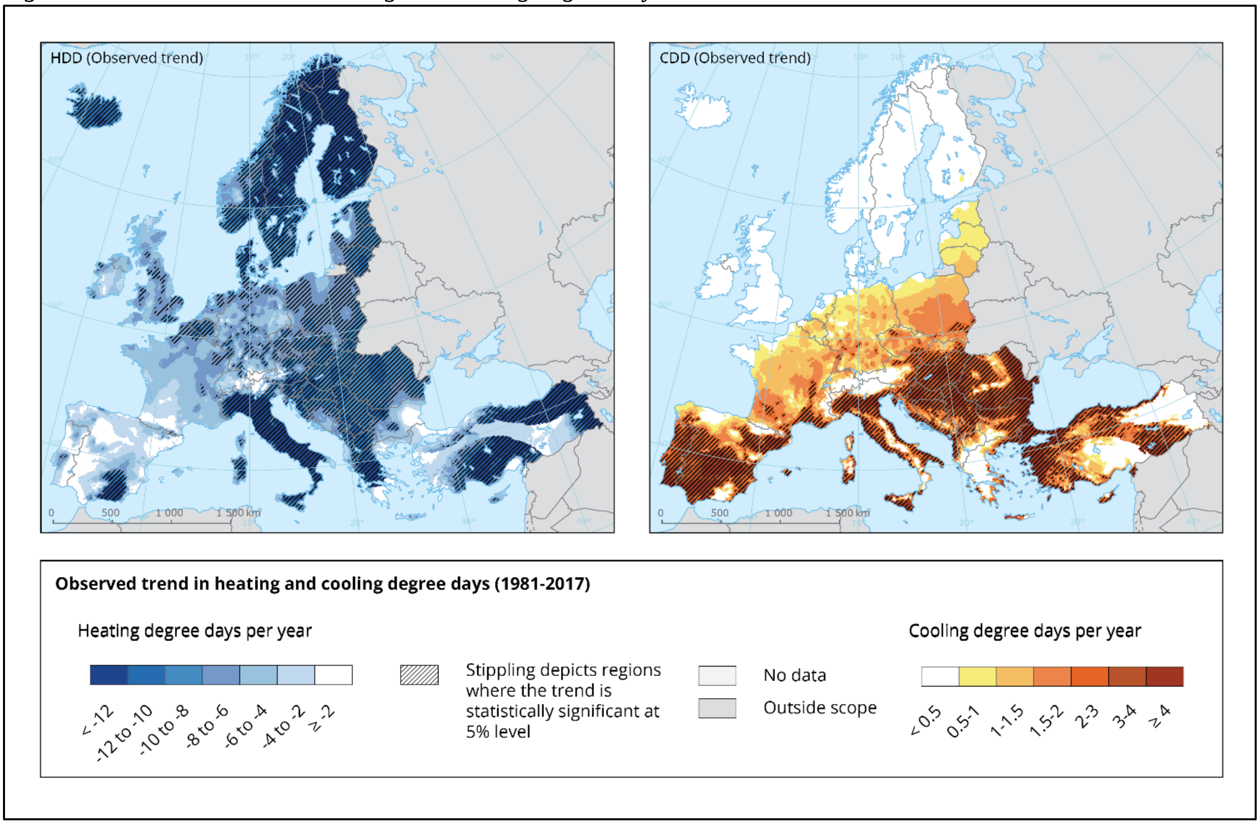
Group	Western Lithuania					
	Number	**%**	**Total surface**	**%**	**Heated area**	**%**
1. Residential buildings	**49 800**		**14 096**		**55 988**	
1.1. Private houses	44 621	8%	6 479	9%	5 229	10%
1.2. Multi-apartment buildings	5 179	13%	7 617	13%	6 138	13%
2. Non-residential buildings	**12 406**		**8 421**		**29 721**	
2.1. Industrial buildings	5 757	12%	3 811	11%	3 811	11%
2.2. Administrative buildings	1 135	11%	993	10%	993	10%
2.3. Educational buildings	476	10%	911	11%	911	11%
2.4. Trading buildings	988	11%	847	12%	847	12%
2.5. Health care buildings	217	12%	363	12%	363	12%
2.6. Cultural facilities	262	4%	201	8%	201	8%
2.7. Accommodation buildings	2 581	110%	791	35%	791	35%
2.8. Service facilities	754	15%	306	14%	306	14%
2.9. Other buildings	236	12%	196	12%	196	12%
Total	**62 206**	**9%**	**22 517**	**11%**	**19 788**	**11%**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Although the western part of the country is affected by the climate of the Baltic Sea, the energy consumption of buildings differs from the rest of the country only within a range of 2%[7]. Since the differences between the western part and the rest of the country are not significant in terms of energy consumption, and the thermal energy consumption for heating the building is taken from the SPSC EPB certificate register base, the calculation methodology of which uses average Lithuanian climate parameters, the entire territory of Lithuania and the LTRS are treated as one climate zone.

[7] Study on the establishment of a long-term strategy to mobilise investment in the renovation of the national stock of residential and commercial buildings under both public and private ownership

Figure 7. Trends observed in heating and cooling degree days in EEA countries



Source: European Environment Agency, https://www.eea.europa.eu/data-and-maps/figures/trend-in-heating-and-cooling-1

Climate change forecast

According to Lithuania's seventh National Communication to the United Nations Framework Convention on Climate Change, average maximum and minimum air temperatures in Lithuania are projected to rise in the 21st century. According to the climate forecast study, the maximum increase in average air temperature is expected during the cold season. In Lithuania, the average air temperature may rise by 1.5–5.1°C until 2100, and in certain months in north-eastern Lithuania and up to 7°C. In 2035, the average air temperature may rise by 1.1–1.4°C in the whole of Lithuania. Cold periods (with minimum air temperature ≤ -20°C) are also forecast to occur only in January–February.

In a warming climate, the change in average air temperature will lead to a reduction in primary energy consumption in buildings. This factor has been considered in the modelling of the primary energy consumption forecast (see Chapter 5.1.1).

1.2.2. Thermal energy consumption for heating the building

Thermal energy consumption for heating a building includes:

- thermal energy consumption due to losses in the building envelope;
- thermal energy consumption due to natural and mechanical ventilation, infiltration and door opening.

In the table below, the annual thermal energy consumption for building heating by energy performance class, GWh, to be calculated for the building stock is presented.

Table 17. Thermal energy consumption of the building stock for heating the building in accordance with the EPC (GWh)

Group	Energy performance class						Total	Total (%)
	≤D	C	B	A	A+	A++		
1. Residential buildings	**10 517**	**2 085**	**799**	**65**	**7**	**0**	**13 473**	**67%**
1.1. Private houses	6 811	1 743	474	56	5	0	**9 089**	45%

1.2. Multi-apartment buildings	3 706	342	325	9	2	0	**4 384**	22%
2. Non-residential buildings	**5 728**	**464**	**424**	**38**	**13**	**4**	**6 670**	**33%**
2.1. Industrial buildings	3 475	120	159	20	7	4	**3 784**	19%
2.2. Administrative buildings	710	67	37	11	2	0	**828**	4%
2.3. Educational buildings	517	112	44	0	0	0	**674**	3.3%
2.4. Trading buildings	333	57	97	2	2	0	**493**	2.4%
2.5. Health care buildings	158	36	28	0	0	0	**222**	1.1%
2.6. Cultural facilities	120	28	24	3	1	0	**175**	0.9%
2.7. Accommodation buildings	172	15	8	0	0	0	**195**	1.0%
2.8. Service facilities	154	13	12	1	0	0	**180**	0.9%
2.9. Other buildings	88	15	15	0	0	0	**119**	0.6%
Total	**16 245**	**2 549**	**1 222**	**103**	**19**	**4**	**20 143**	100%
Total (%)	81%	13%	6%	1%	0%	0%	100%	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that:

- Residential buildings consume 2/3 (67%) of the total thermal energy of the building stock for heating the building. 45% are used by private houses, and 22% are used by multi-apartment houses;
- 4/5 (81%) of the total building stock uses less thermal energy than energy for heating than buildings of efficiency class C. The most significant consumption in this segment is in private houses (34%), multi-apartment buildings (18%), and industrial buildings (17%);
- Accordingly, residential buildings in energy performance class lower than C consuming more than half (52%) of the total thermal energy of the building stock for heating the building shall be treated as a priority segment in the context of the LTRS.

1.2.3. Thermal energy consumed for hot water production

Thermal energy demand for hot water includes:

- thermal energy consumption of the building's heat source for hot water production;
- thermal energy consumption for heat losses in the piping between the hot water production plant and the distribution risers;
- thermal energy consumption due to heat losses in the pipelines of hot water distribution racks;
- thermal energy consumption due to heat losses in hot water indoor distribution pipelines.

The table below shows the annual thermal energy consumption for hot water production by energy performance class, GWh, to be calculated for the building stock.

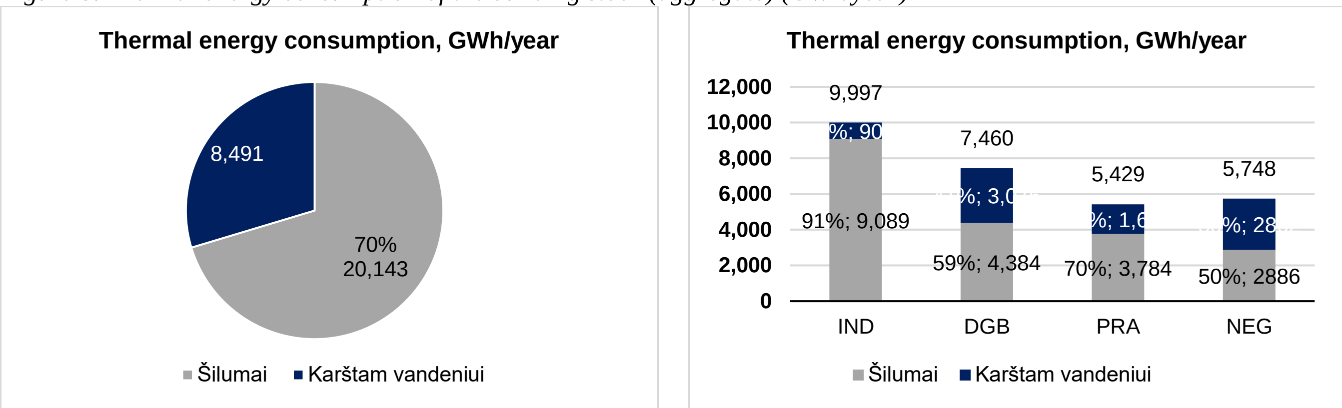
Table 18. Thermal energy consumption for hot water production in accordance with the EPC (GWh)

Group	Energy performance class						Total	Total (%)
	≤D	C	B	A	A+	A++		
1. Residential buildings	**2 885**	**608**	**442**	**40**	**8**	**1**	**3 984**	**47%**
1.1. Private houses	472	310	106	19	2	0	**908**	11%
1.2. Multi-apartment buildings	2 414	298	336	21	6	1	**3 076**	36%
2. Non-residential buildings	**3 666**	**353**	**417**	**49**	**18**	**3**	**4 508**	**53%**
2.1. Industrial buildings	1 504	47	76	12	3	3	**1 645**	19%
2.2. Administrative buildings	647	52	40	21	5	0	**765**	9%
2.3. Educational buildings	462	81	46	1	1	0	**590**	6.9%
2.4. Trading buildings	303	44	106	5	4	0	**462**	5.4%
2.5. Health care buildings	173	38	41	1	0	0	**252**	3.0%
2.6. Cultural facilities	138	45	51	7	3	0	**243**	2.9%
2.7. Accommodation buildings	157	11	8	0	0	0	**177**	2.1%
2.8. Service facilities	188	14	15	2	1	0	**219**	2.6%
2.9. Other buildings	95	22	35	1	1	0	**154**	1.8%
Total	**6 552**	**961**	**860**	**89**	**26**	**4**	**8 492**	100%
Total (%)	77%	11%	10%	1%	0%	0%	100%	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The figure below shows the aggregated data for the building stock by thermal energy consumption.

Figure 8. Thermal energy consumption of the building stock (aggregate) (GWh/year)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that:

- 3/4 (77%) of the total building stock uses less than energy efficiency class C for the hot water production. The most significant consumption in this segment is in multi-apartment buildings (28%) and other non-residential buildings (25%);
- the consumption of total thermal energy for hot water accounts for 30% of total thermal energy consumption, but varies significantly between building types;
- individual buildings use only 1/10 (9%) of the thermal energy for hot water production. Meanwhile, industrial buildings account for 30%, multi-apartment buildings for 41% and other non-residential buildings for 50%.

1.2.4. Electrical energy consumption

Electrical energy costs include:

- electricity consumption for lighting;
- electricity consumption for appliances in the building;
- electricity consumption outside the building (related to the use of building);
- electricity consumption of ventilation installations (if ventilation is available);

- electricity consumption for cooling;
- total electricity consumption of the building;
- total electricity consumption of the building (without ventilation).

The annual electricity consumption by energy performance class of the building stock is presented in the table below.

Table 19. Building stock electricity consumption by EPC (GWh)

Group	Energy performance class						Total	Total (%)
	≤D	C	B	A	A+	A++		
1. Residential buildings	**1 057**	**362**	**227**	**23**	**4**	**0**	**1 675**	**66%**
1.1. Private houses	355	233	80	14	1	0	**684**	27%
1.2. Multi-apartment buildings	702	129	147	9	3	0	**991**	39%
2. Non-residential buildings	**622**	**95**	**129**	**18**	**7**	**2**	**873**	**34%**
2.1. Industrial buildings	334	24	44	7	2	1	**413**	16%
2.2. Administrative buildings	101	16	13	7	2	0	**139**	5%
2.3. Educational buildings	37	14	8	0	0	0	**59**	2.3%
2.4. Trading buildings	51	15	36	2	2	0	**104**	4.1%
2.5. Health care buildings	24	9	10	0	0	0	**43**	1.7%
2.6. Cultural facilities	16	6	8	2	1	0	**33**	1.3%
2.7. Accommodation buildings	24	4	3	0	0	0	**30**	1.2%
2.8. Service facilities	22	3	4	0	0	0	**31**	1.2%
2.9. Other buildings	12	4	5	0	0	0	**21**	0.8%
Total	**1 679**	**457**	**356**	**42**	**12**	**2**	**2 547**	100%
Total (%)	66%	18%	14%	2%	0%	0%	100%	

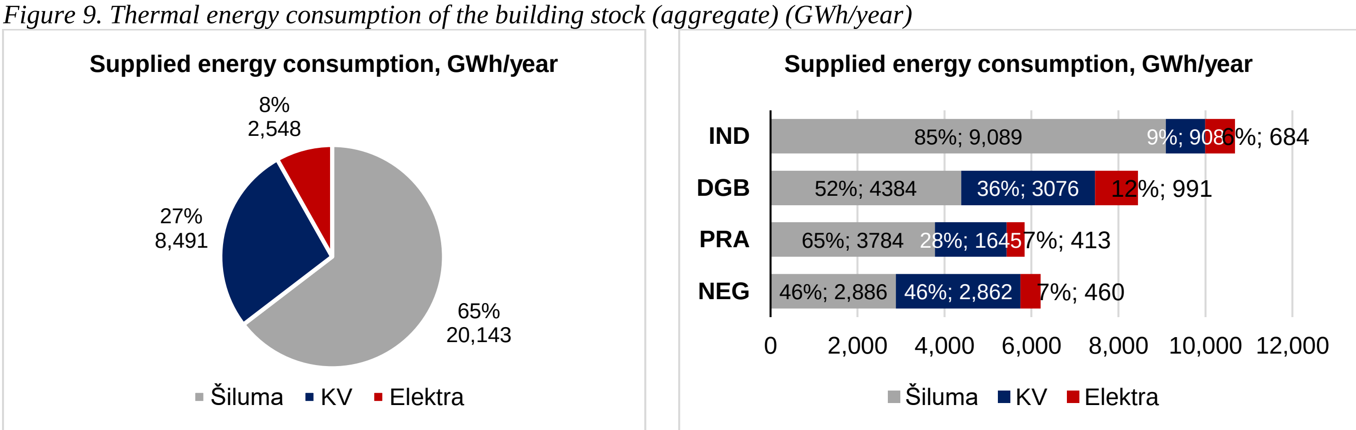
Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that:

- the electricity consumption of the building stock is 11 times lower than the thermal energy consumption;
- traditional renovation measures lead to the most significant decrease in thermal energy consumption.

The figure below shows the aggregated data for the building stock by supplied energy consumption.

Figure 9. Thermal energy consumption of the building stock (aggregate) (GWh/year)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

1.2.5. Primary energy consumption

Primary energy consumption data of the building stock were calculated for each building reference using data on:

- thermal and electrical energy consumption (see Chapters 1.2.2 to 1.2.4);
- the primary energy source (type of fuel), i.e. the energy production structure of the building stock (see below);

- the emission factor for non-renewable primary energy, renewable primary energy and CO_2 from energy sources used for energy production (see below).

Structure and factors of energy production of the building stock

The following were used to determine the energy production structure of the building stock:

- data of the register of multi-apartment buildings connected to the DH (RPR data);
- data of the annual energy and fuel balance of the Department of Statistics.

Table 20. Structure of thermal energy production of the building stock

Use	Sources					Comment
	DH	Gas	Biofuel	Other (non-RES)	Electricity	
Multi-apartment buildings	–	36%	42%	21%	–	Not connected to DH
Private houses	–	36%	42%	21%	–	
Industrial facilities	23%	28%	33%	17%	–	
Other non-residential buildings	23%	28%	33%	17%	–	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Primary energy factors[8] are provided in STR 2.01.02:2016 for the calculation of primary energy.

Table 21. Emission factor values for non-renewable primary energy, renewable primary energy and CO_2 from energy sources used for energy production

Indicator	Unit of measure	DH	Gas	Biofuel	Other (non-RES)	Electricity
Primary non-renewable energy factor	units	0.63	1.10	0.20	1.10	2.30
Primary renewable energy factor	units	0.62	0.00	1.00	0.00	0.20
CO_2 emission factor	$kgCO_2/kWh$	0.10	0.22	0.04	0.30	0.42

Source: STR 2.01.02:2016

Primary energy consumption of the building stock

The table below shows the calculated primary energy consumption by energy performance class (GWh) of the building stock.

Table 22. Primary energy consumption by EPC of the building stock (GWh year)

Group	Energy performance class						Total	Total (%)
	≤D	C	B	A	A+	A++		
1. Residential buildings	**19 252**	**4 203**	**2 111**	**187**	**29**	**2**	**25 783**	**63%**
1.1. Private houses	9 704	3 068	897	126	12	0	**13 806**	34%
1.2. Multi-apartment buildings	9 548	1 135	1 213	61	17	2	**11 977**	29%
2. Non-residential buildings	**12 339**	**1 176**	**1 300**	**149**	**55**	**12**	**15 031**	**37%**
2.1. Industrial buildings	6 552	252	379	55	17	11	**7 267**	18%
2.2. Administrative buildings	1 810	178	121	57	13	0	**2 179**	5%
2.3. Educational buildings	1 216	256	123	1	2	0	**1 599**	3.9%
2.4. Trading buildings	858	153	326	13	11	0	**1 361**	3.3%
2.5. Health care buildings	440	108	104	1	0	0	**653**	1.6%
2.6. Cultural facilities	337	100	109	16	6	0	**568**	1.4%
2.7. Accommodation buildings	437	39	25	1	1	0	**503**	1.2%
2.8. Service facilities	448	38	43	4	3	0	**536**	1.3%
2.9. Other buildings	241	52	70	2	3	0	**367**	0.9%

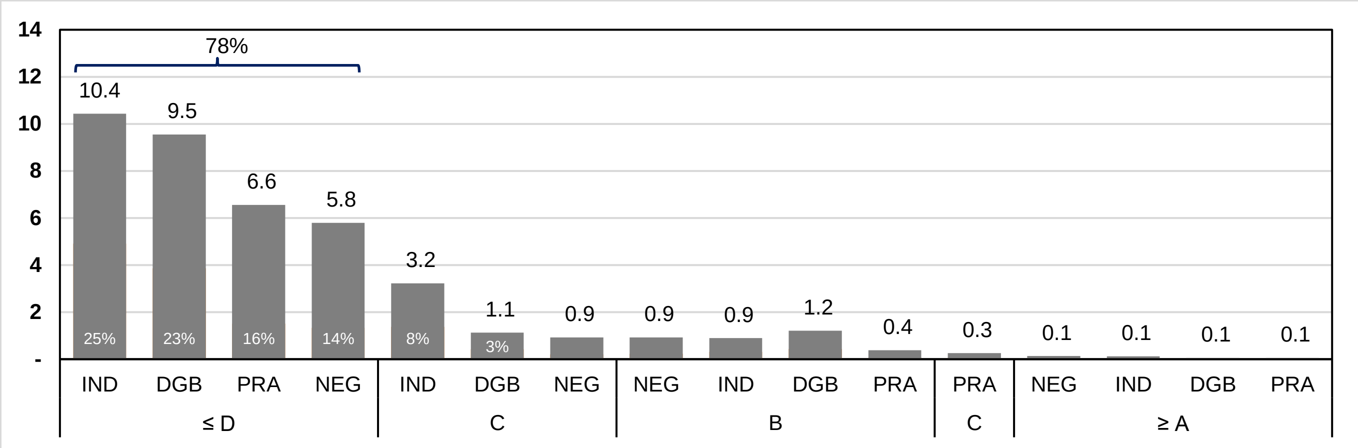
[8] Table 2.18 of building code STR 2.01.02:2016 'Design and certification of energy performance of buildings'

Total	**31 591**	**5 379**	**3 411**	**336**	**84**	**14**	**40 815**	100%
Total (%)	77%	13%	8%	0.8%	0.2%	0.03%	100%	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The figure below shows the aggregated data on the primary energy consumption by energy performance class of the building stock.

Figure 10. Primary energy consumption of the building stock by EPC and group (GWh year)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the data above, it can be observed that:

- residential buildings consume 2/3 (63%) of the total primary energy of the building stock for heating purposes. 34% are consumed by private houses, and 29% are consumed by multi-apartment buildings;
- 4/5 (77%) of the total primary energy consumption of the building stock is consumed by buildings in energy performance class D and lower. The most significant consumption in this segment is in private houses (31%), multi-apartment buildings (30%), and industrial buildings (21%);
- accordingly, residential buildings of energy performance class D and lower and consuming almost half (47%) of the total primary energy of the building stock are considered as a priority segment in the context of the LTRS.

Primary energy consumption of the building stock by fuel and energy type

The table below shows the primary energy consumption of the building stock by fuel and energy type.

Table 23. Primary energy consumption of the building stock by fuel and energy type (GWh/year)

Group	Fuel and energy type					Total	Total (%)
	DH	Biofuel	Gas[9]	Solid fuels	Electricity		
1. Residential buildings	**6 804**	**8 560**	**2 888**	**1 802**	**5 730**	**25 783**	**63%**
1.1. Private houses	37	7 208	2 450	1 519	2 593	**13 806**	34%
1.2. Multi-apartment buildings	6 766	1 352	439	284	3 136	**11 977**	29%
2. Non-residential buildings	**3 220**	**2 012**	**4 767**	**2 852**	**2 182**	**15 031**	**37%**
2.1. Industrial buildings	1 489	989	2 353	1 402	1 033	**7 267**	18%
2.2. Administrative buildings	475	284	670	403	346	**2 179**	5%
2.3. Educational buildings	353	232	538	329	146	**1 599**	4%
2.4. Trading buildings	306	164	398	233	260	**1 361**	3%
2.5. Health care buildings	136	86	201	122	108	**653**	1.60%
2.6. Cultural facilities	161	67	162	95	83	**568**	1.39%
2.7. Accommodation buildings	103	68	159	97	76	**503**	1.23%
2.8. Service facilities	113	72	171	102	77	**536**	1.31%
2.9. Other buildings	84	48	114	68	52	**367**	0.90%
Total	**10 023**	**10 571**	**7 655**	**4 654**	**7 911**	**40 815**	100%

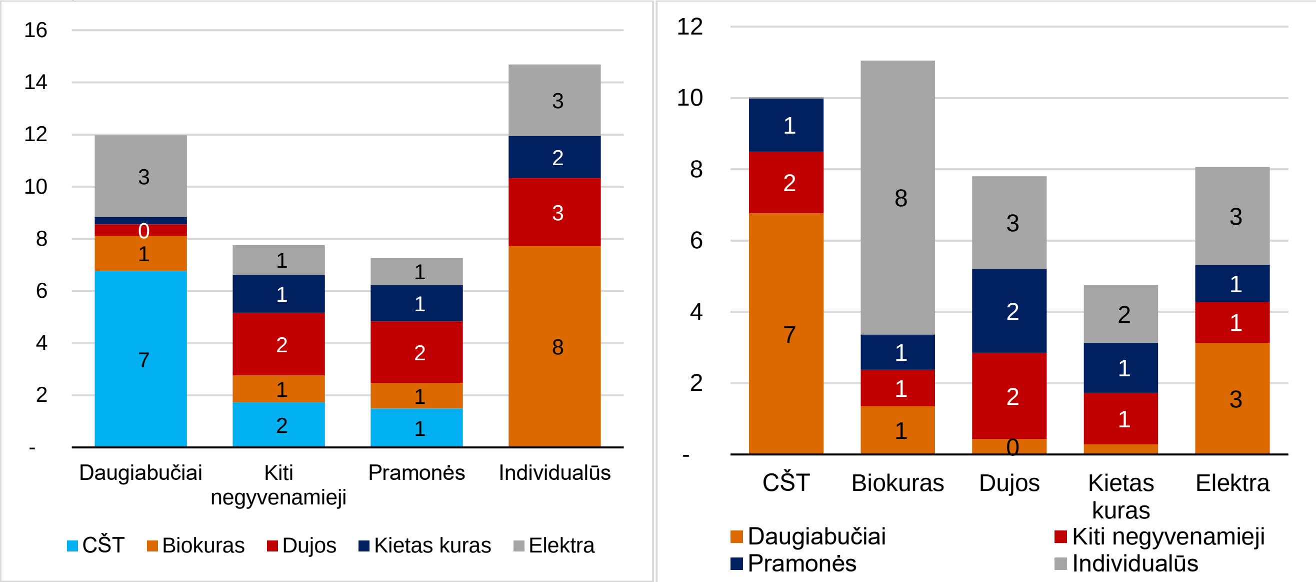
[9] Natural gas

Total (%)	25%	26%	19%	11%	19%	100%	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The figure below shows the aggregated data on the primary energy consumption of the building stock by fuel and energy type.

Figure 11. Primary energy consumption of the building stock by fuel and energy type, and the premises groups (aggregated) (TWh/year)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the data above, it can be observed that:

- fossil fuels (natural gas and solid fuels) account for ~30% of primary energy consumption;
- Most of fossil fuel consumption is used by private houses (32%) and industrial buildings (31%);
- fossil fuel buildings are a priority segment in the quest for decarbonisation;
- some biofuel consuming sources of production are polluting (e.g. individual home furnaces, old boilers, etc.). Accordingly, although the fuel is not fossil, specific LTRS measures are applicable.

1.3. CO_2 EMISSIONS FROM THE BUILDING STOCK

Primary energy consumption data of the building stock were calculated for each building reference using data on:

- thermal and electrical energy consumption (see Chapters 1.2.2 to 1.2.4).
- The primary energy source (type of fuel), i.e. the energy production structure of the building stock (see Chapter 1.2.5).
- The emission factor for non-renewable primary energy, renewable primary energy and CO_2 from energy sources used for energy production (see Table 21).

The table below shows the calculated CO_2 emissions of the building stock by building use and EPC.

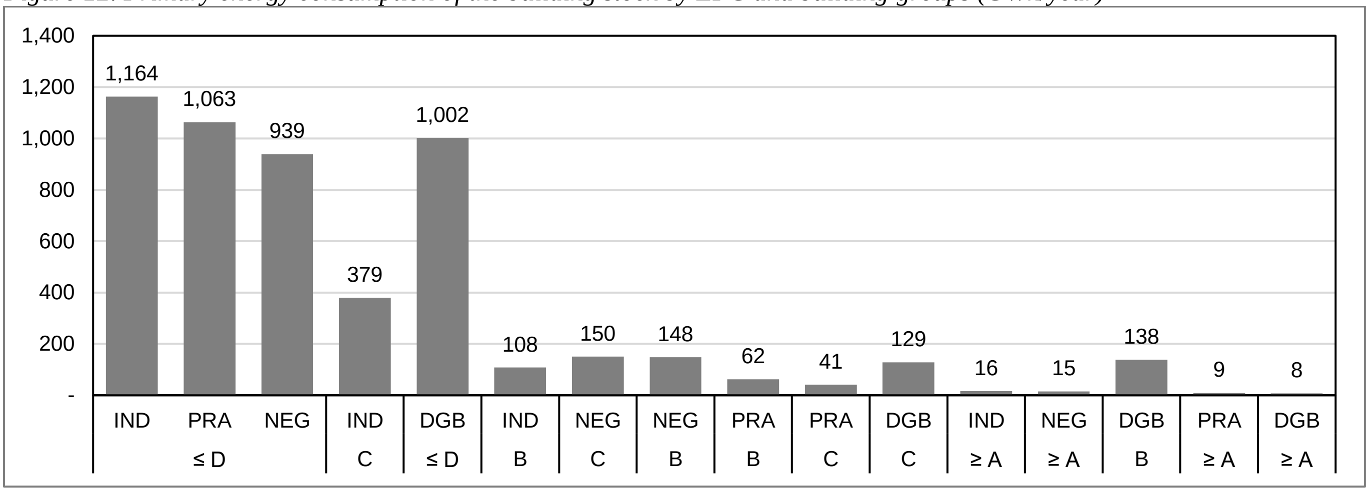
Table 24. CO_2 emissions from the building stock ($ktCO_2$/year)

Group	Energy performance class						Total	Total (%)
	≤D	**C**	**B**	**A**	**A+**	**A++**		
1. Residential buildings	**2 084**	**490**	**246**	**23**	**4**	**0**	**2 848**	**54%**
1.1. Private houses	1 082	361	108	16	1	0	**1 569**	30%
1.2. Multi-apartment buildings	1 002	129	138	8	2	0	**1 279**	24%
2. Non-residential buildings	**2 002**	**191**	**210**	**24**	**9**	**2**	**2 438**	**46%**
2.1. Industrial buildings	1 063	41	62	9	3	2	**1 180**	22%
2.2. Administrative buildings	294	29	19	9	2	0	**353**	7%
2.3. Educational buildings	197	42	20	0	0	0	**259**	4.9%
2.4. Trading buildings	139	25	53	2	2	0	**221**	4.2%
2.5. Health care buildings	71	18	17	0	0	0	**106**	2.0%
2.6. Cultural facilities	55	16	17	2	1	0	**91**	1.7%
2.7. Accommodation buildings	71	6	4	0	0	0	**82**	1.5%
2.8. Service facilities	73	6	7	1	0	0	**87**	1.6%
2.9. Other buildings	39	8	11	0	0	0	**59**	1.1%
Total	**4 086**	**681**	**456**	**47**	**12**	**2**	**5 286**	100%
Total (%)	77%	13%	9%	1%	0%	0%	100%	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The figure below shows the aggregated CO_2 emissions data for the building stock.

Figure 12. Primary energy consumption of the building stock by EPC and building groups (GWh/year)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that:

- over 3/4 (77%) of CO_2 emissions of the building stock are emitted by buildings with the EPC lower than C;
- accordingly, residential buildings with the EPC lower than C, and all buildings using fossil fuels are treated as a priority segment in the context of the reduction of CO_2 emissions.

1.4. SPECIFIC SEGMENTS OF THE BUILDING STOCK

1.4.1. Buildings with the lowest energy performance

The buildings classified as having the lowest energy performance shall be buildings in energy performance class D or lower. Buildings with the lowest energy performance account for 2/3 of the building stock in terms of area (see the table below).

Table 25. Building stock by EPC (thousand m^2)

Group	Energy performance class						Total	Total (%)
	≤D	C	B	A	A+	A++		
1. Residential buildings	**79 926**	**31 571**	**15 501**	**1 698**	**283**	**24**	**129 004**	**64%**
1.1. Private houses	37 687	23 728	6 866	1 141	115	2	**69 540**	34%
1.2. Multi-apartment buildings	42 239	7 843	8 634	557	168	22	**59 464**	29%
2. Non-residential buildings	**52 809**	**7 895**	**10 024**	**1 345**	**501**	**96**	**72 670**	**36%**
2.1. Industrial buildings	29 135	1 962	3 534	574	192	93	**35 490**	18%
2.2. Administrative buildings	7 438	1 167	900	482	110	0	**10 097**	5%
2.3. Educational buildings	5 455	1 938	1 081	13	16	0	**8 503**	4.2%
2.4. Trading buildings	3 493	984	2 386	105	95	2	**7 064**	3.5%
2.5. Health care buildings	1 655	619	669	8	1	1	**2 952**	1.5%
2.6. Cultural facilities	1 262	483	595	108	46	1	**2 497**	1.2%
2.7. Accommodation buildings	1 819	258	188	10	4	0	**2 279**	1.1%
2.8. Service facilities	1 619	220	306	30	23	0	**2 199**	1.1%
2.9. Other buildings	932	264	365	15	14	0	**1 589**	0.8%
Total	**132 735**	**39 466**	**25 524**	**3 043**	**784**	**120**	**201 674**	100%
Total (%)	66%	20%	13%	2%	0%	0%	100%	

Source: RPR data (31-12-2019)

Buildings with the lowest energy performance consume more than 3/4 of the primary energy of the building stock (see the table below).

Table 26. Primary energy consumption by EPC of the building stock (GWh year)

Group	Energy performance class						Total	Total (%)
	≤D	C	B	A	A+	A++		
1. Residential buildings	**19 252**	**4 203**	**2 111**	**187**	**29**	**2**	**25 783**	**63%**
1.1. Private houses	9 704	3 068	897	126	12	0	**13 806**	34%
1.2. Multi-apartment buildings	9 548	1 135	1 213	61	17	2	**11 977**	29%
2. Non-residential buildings	**12 339**	**1 176**	**1 300**	**149**	**55**	**12**	**15 031**	**37%**
2.1. Industrial buildings	6 552	252	379	55	17	11	**7 267**	18%
2.2. Administrative buildings	1 810	178	121	57	13	0	**2 179**	5%
2.3. Educational buildings	1 216	256	123	1	2	0	**1 599**	3.9%
2.4. Trading buildings	858	153	326	13	11	0	**1 361**	3.3%
2.5. Health care buildings	440	108	104	1	0	0	**653**	1.6%
2.6. Cultural facilities	337	100	109	16	6	0	**568**	1.4%
2.7. Accommodation buildings	437	39	25	1	1	0	**503**	1.2%
2.8. Service facilities	448	38	43	4	3	0	**536**	1.3%
2.9. Other buildings	241	52	70	2	3	0	**367**	0.9%
Total	**31 591**	**5 379**	**3 411**	**336**	**84**	**14**	**40 815**	100%
Total (%)	77%	13%	8%	0.8%	0.2%	0.03%	100%	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The primary energy consumption of buildings with the lowest energy performance, in kWh/m², is presented in the table below.

Table 27. Average energy consumption of buildings by use and EPC (kWh/m²/year)

Group	Energy performance class						Average
	≤D	C	B	A	A+	A++	
1. Residential buildings							
1.1. Private houses	258	129	131	110	101	78	**199**
1.2. Multi-apartment buildings	226	145	141	110	101	104	**201**
2. Non-residential buildings							
2.1. Industrial buildings	225	129	107	96	91	122	**205**
2.2. Administrative buildings	243	153	134	117	118	–	**216**
2.3. Educational buildings	223	132	114	95	100	–	**188**
2.4. Trading buildings	245	155	137	120	121	116	**193**
2.5. Health care buildings	266	174	156	136	136	132	**221**
2.6. Cultural facilities	267	207	183	144	133	193	**227**
2.7. Accommodation buildings	240	151	132	112	114	–	**221**
2.8. Service facilities	277	173	140	125	119	–	**244**
2.9. Other buildings	259	196	191	142	185	–	**231**
Average	**238**	**136**	**134**	**110**	**107**	**119**	

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that individual houses, multi-apartment buildings and industrial buildings in the energy performance class lower than C are the most energy consuming segment of the lowest energy efficiency. Accordingly, it is considered a priority segment in the context of the LTRS. It is likely that the renovation of this segment would achieve the highest energy savings through the investment made.

1.4.2. Abandoned and unheated buildings

A significant segment of the building stock is abandoned and unheated buildings. This segment is important because although buildings are potentially fit for use, they do not actually consume (or consume very little) energy, i.e. they should not be reflected in the energy consumption of the building stock and, consequently, should be a significant part of the renovation plan.

The most significant part of these buildings are unused buildings due to local (from districts to cities) and international (to other countries) migration. It is important to note that although migration has increased significantly, there is no data on its impact on the use of buildings and/or on heating.

The remaining part of such buildings falls into the category of buildings without owners, the procedure for the accounting, storage, and sale of which is laid down in the Rules on the transfer, accounting, storage, sale, return and recognition as waste of owner-occupied, confiscated, inherited, and transferred to the State property, material evidence, treasures and finds[10]. According to them, the lists of such buildings are drawn up by the municipalities.

The table below shows the building stock adjustments, i.e. the reduction of the building stock by assessing potentially unused and/or unheated buildings.

[10] Resolution No 634 of the Government of the Republic of Lithuania of 26 May 2004

Table 28. Adjustment of the building stock: not used and/or unheated buildings

Year of construction	Multi-apartment buildings	Private houses	Storage facilities	Other non-residential buildings
up to 1900	5%	10%	50%	5%
1901–1960	5%	10%	40%	5%
1961–1992	5%	10%	30%	5%
1993–2005	–		20%	–
2006–2014	–		10%	–

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

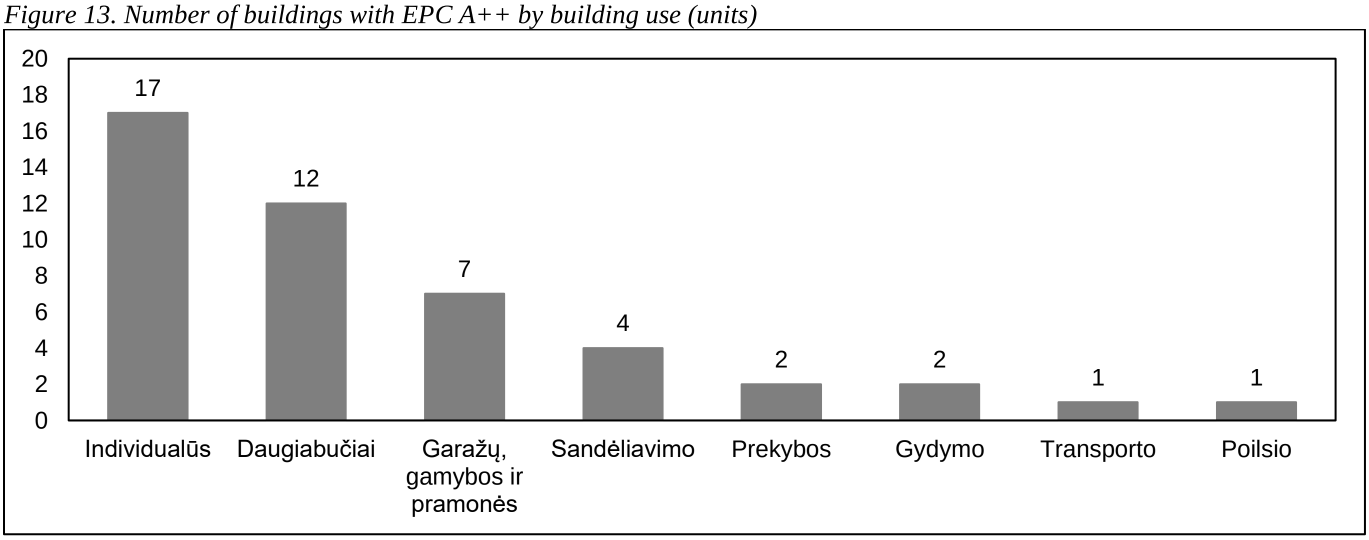
1.4.3. Nearly zero energy buildings

According to the legislation currently in force, nearly energy-neutral buildings in Lithuania are buildings meeting the requirements of energy performance class A++:

- According to Article 51(5) of the Law of the Republic of Lithuania on Construction: ‘5. <...> From 1 January 2019, new buildings being constructed by state and municipal institutions, bodies and undertakings, and from 1 January 2021, all new buildings being constructed must be nearly zero energy buildings within the meaning of the Law of the Republic of Lithuania on Energy from Renewable Sources. Requirements for nearly zero-energy buildings are established by the Government or its authorised institutions. <...>’;
- According to point 4.17 of STR 2.01.02:2016 Design and certification of energy performance of buildings, ‘nearly zero energy buildings mean buildings meeting the requirements of the Regulation for buildings in energy performance category A++, i.e. buildings with a remarkably high energy performance and an energy consumption close to zero or very low; the majority of energy consumed comes from renewable sources, including locally produced or nearby renewable energy;’.
- According to point 21 of STR 2.01.02:2016 Design and certification of energy performance of buildings, ‘The energy performance class of buildings under construction for which the application for a construction permit for a new construction works was submitted after 1 January 2021, where construction authorisations are not mandatory, shall be at least A++.’.

According to the SPSC data register[11], as of January 2020, 46 buildings of energy performance class A++ have been certified in Lithuania. The total area of these buildings is 149 thousand m^2. Most of buildings of energy performance class A++ are in Vilnius (16 buildings), Kaunas (10 buildings), and Klaipėda (5 buildings) counties.

Figure 13. Number of buildings with EPC A++ by building use (units)



Source: SPSC data register.

[11] https://www.spsc.lt/cms/index.php?option=com_content&view=article&id=57&Itemid=331&lang=lt

1.4.4. Renovated buildings

The Demonstration Project on Housing Energy Saving carried out in 1996 under an agreement with the World Bank can be considered as the start of systematic renovation of buildings at national level. Information on this and subsequent stages of building renovation is provided below.

Demonstration Project on Housing Energy Saving (1996–2003)
Under an agreement with the World Bank, the Demonstration Project on Housing Energy Saving was implemented in 1996–2003; it was one of the multi-apartment renovation projects for energy savings (modernisation of heating stations and heating systems, replacement of windows and external doors, insulation of roofs and walls, etc.) financed from the Revolving Fund established by the World Bank. The state budget of the Republic of Lithuania reimbursed 30% of the investment. Under this project, more than 700 multi-apartment buildings were partially renovated (excluding wall insulation), with an investment of over LTL 70 million, and the thermal energy consumption of these buildings was reduced by about 24%.

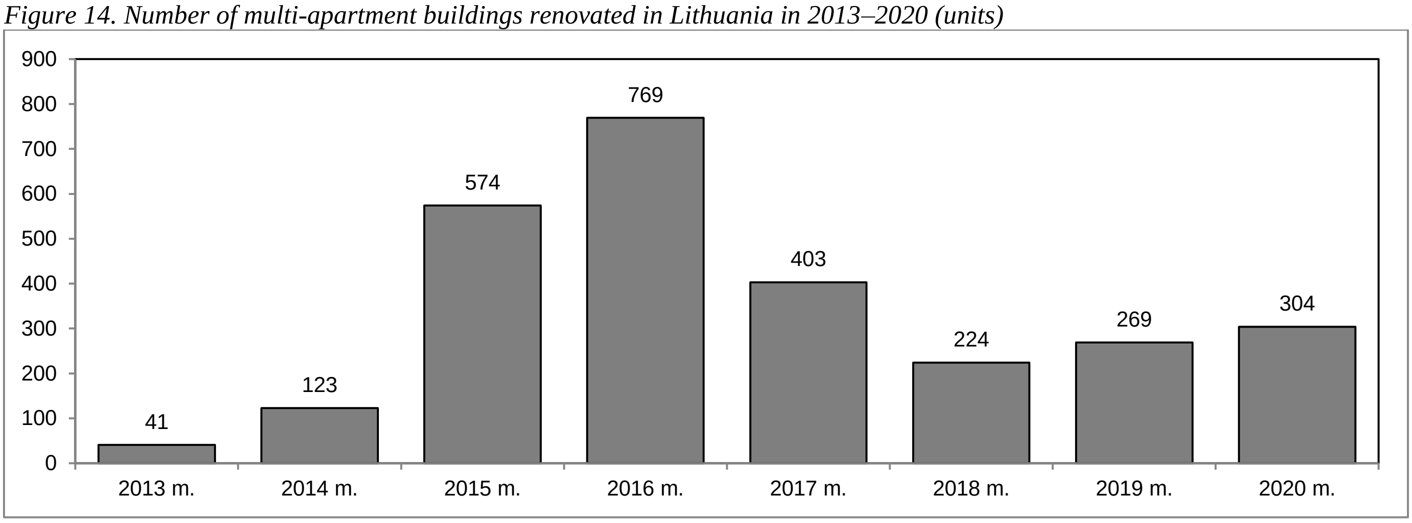
Renovation of multi-apartment buildings primarily by enhancing their energy efficiency (2007–2013)
The renovation of multi-apartment buildings was also financed under the Operational Programme of 2007–2013 'Promotion of Cohesion', Priority 1 'Local and urban development, conservation of cultural heritage and nature, and adaptation for tourism development', Implementing measure VP3-1.1-VRM-03-R 'Renovation of multi-apartment buildings primarily by enhancing their energy efficiency' (under the responsibility of the Ministry of the Interior of the Republic of Lithuania). LTL 163.471 million have been allocated for this measure. The funds were distributed to municipalities classified as problem areas under Resolution No 112 of the Government of the Republic of Lithuania of 31 January 2007 on problem areas. By 2013, about 150 multi-apartment buildings were renovated.

Programme for the renovation of multi-apartment buildings (2013–2020)
As part of the programme for the renovation of multi-apartment buildings, 2 631 multi-apartment buildings were renovated in the country between 2013 and November 2020 (another 419 buildings had been renovated before 2013), with investments amounting to around EUR 750 million, or EUR 290 thousand per multi-apartment building per renovation, compared to the total number of multi-apartment buildings in Lithuania of 37 136, which were built prior to 1993, i.e. 8% of multi-apartment buildings have been renovated.

In November 2020, 513 multi-apartment building renovation projects were carried out in the country. The scale of the renovation of multi-apartment buildings was initially small due to the low involvement of the residents in the renovation process, later faced with delays and lack of funding. Currently, renovation of larger multi-apartment buildings (with more apartments) is being carried out, the investments of which are higher.

A total of 304 multi-apartment buildings were renovated in 2020.

Figure 14. Number of multi-apartment buildings renovated in Lithuania in 2013–2020 (units)



Source: BETA

Measures taken by citizens' initiative

The owners of buildings are also renovating on their own initiative. The table below provides information on the renovation measures applied in households.

Table 29. Partial renovation of dwellings (energy consumption survey information), %

Location	Implemented measure	Year	
		2009	**2018**
Town	Replaced heating system or part thereof	25.1	28.9
	Insulated exterior walls of the house	12.3	22.5
	Renovated and/or insulated roof	36.3	32.4
	Replaced windows	86.6	96
Village	Replaced heating system or part thereof	36	44
	Insulated exterior walls of the house	24.6	31.8
	Renovated and/or insulated roof	25.5	37.2
	Replaced windows	90.5	95
Town and village	Replaced heating system or part thereof	28.1	33.8
	Insulated exterior walls of the house	15.7	25.5
	Renovated and/or insulated roof	33.3	33.9
	Replaced windows	87.7	95.7

Source: Department of Statistics

To summarise the above data, it can be observed that:

- a significant share of individual households has been renovated as a stock (therefore, the EPC has been adjusted/the calculated energy consumption has been reduced).
- renovation of multi-apartment buildings is gaining momentum, but currently still lags behind the target volumes (for a more detailed overview of disturbances and barriers, see Chapter 4).

1.4.5. Public buildings

The tables below provide an overview of the buildings owned by public entities (the state and municipalities).

Table 30. Number of public buildings by group and energy performance class (units)

Group	Energy performance class				Total	Total (%)	Of the total stock, %.
	≤D	**C**	**B**	**≥A**			
Private houses	1 487	611	16	1	**2 115**	13%	0.4%
Multi-apartment buildings	566	147	90	11	**814**	5%	2%
Industrial facilities	3 073	119	77	1	**3 270**	20%	7%
Other non-residential buildings	8 259	1 235	819	37	**10 350**	63%	25%
Total	**13 385**	**2 113**	**1 002**	**50**	**16 549**	100%	3%
Total (%)	81%	13%	6%	0.3%	100%		

Source: RPR data (31-12-2019)

Table 31. Area of public buildings by group and energy performance class (thousand m²)

Group	Energy performance class				Total	Total (%)	Of the total stock, %.
	≤D	**C**	**B**	**≥A**			
Private houses	185	75	3	0	**262**	2%	0.4%
Multi-apartment buildings	868	222	147	5	**1,242**	7%	2%
Industrial facilities	1,182	42	48	0	**1 272**	8%	4%
Other non-residential buildings	9 123	2 882	1 999	58	**14 061**	84%	38%
Total	**11 356**	**3 220**	**2 197**	**64**	**16 837**	100%	8%
Total (%)	67%	19%	13%	0.4%	100%		

Source: RPR data (31-12-2019), the authors of the study to develop the long-term renovation strategy of Lithuania

Table 32. Primary energy consumption of public buildings by group and EPC (GWh/year)

Group	Energy performance class				Total	Total (%)	Of the total stock, %.
	≤D	C	B	≥A			
Private houses	51	10	0	0	**61**	2%	0.4%
Multi-apartment buildings	183	31	22	1	**237**	7%	2%
Industrial facilities	240	6	6	0	**252**	7%	3%
Other non-residential buildings	2,177	425	274	8	**2 884**	84%	37%
Total	**2 651**	**472**	**301**	**8**	**3 434**	100%	8%
Total (%)	77%	14%	9%	0.2%	100%		

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that:

- the public building stock represents an insignificant part of the building stock, both in terms of volume (number and area) and primary energy consumption;
- Most of public buildings are of the worst energy performance class and represent a significant share of non-residential buildings;
- accordingly, the renovation of public buildings would not have a significant impact on the reduction of energy consumption at national level.
- this intensive and successful renovation programme for public buildings could serve as a model to be followed.

1.5. ESSENTIAL OBSERVATIONS OF THE CHAPTER

- ✓ Only 2% of the buildings of the building stock (7% of the surface) are public (municipal and state) property, i.e. only this part of the transformation of the building stock can be reliably planned and controlled from a public perspective. The rest of the building owners must make their own decision to participate in the renovation.
- ✓ Almost half (45%) of the building stock consists of mixed ownership, i.e. managed by both public and private, as well as joint owners. This may further complicate the decision-making process of building owners.
- ✓ 58% of the surface of the building stock consists of buildings constructed between 1961 and 1992. The architectural and structural diversity of buildings in this construction period is not great. This creates preconditions for the implementation of repetitive (standard) renovation solutions.
- ✓ 75% of the surface of the building stock were built before 1992. Accordingly, at the end of the LTRS's implementation (2050), most of the existing building stock will be over 60 years old, and their renovation (e.g. the roof repair) will be mandatory to continue their operation.
- ✓ Residential buildings account for 2/3 (63%) of the primary energy consumption of the total building stock, including 34% consumed by private houses, and 29% by multi-apartment buildings.
- ✓ 4/5 (77%) of the total primary energy consumption of the building stock is consumed by buildings in energy performance class D and lower, this segment of the building stock is treated as a priority in the context of the LTRS.

2. MOST COST-EFFECTIVE RENOVATION OPTIONS

Article 2a(1)(b) of the EPBD provides that each LTRS shall encompass 'the identification of cost-effective approaches to renovation relevant to the building type and climatic zone, considering potential relevant trigger points, where applicable, in the life-cycle of the building;'.

The most cost-effective way of renovation was determined by combining three main assessment parameters:

1. Financial payback, where a point is simulated beyond which each additional EUR 1 invested generates a financial benefit of less than EUR 1 (in terms of primary energy and CO_2 savings) at the level of the building stock.
2. Economic payback, where a point is simulated beyond which each additional EUR 1 invested generates economic benefits of less than EUR 1 (financial benefit + GDP growth value + other social benefits value) at the level of the building stock.
3. Technical constraints, i.e. technical (engineering) barriers that would prevent the implementation of the chosen cost-effective renovation method.

The most cost-effective way of renovation was determined as follows:

- Formation of renovation packages (Chapter 2.1).
- Determination of the investment price (Chapter 2.2).
- Determination of energy and CO_2 savings (Chapter 2.3).
- Determination of other simulation parameters (Chapter 2.4).
- Determination of the simulation algorithm (Chapter 2.5).
- Determination of the financially effective method (Chapter 2.6).
- Determination of the cost-effective method (Chapter 2.7).
- Evaluation of technical constraints (Chapter 2.8).
- Evaluation of initiation moments (Chapter 2.9).

2.1. RENOVATION PACKAGES

The renovation packages have been developed to identify the most cost-effective renovation options.

All typical renovation measures can be divided into two groups:

- Energy efficiency improvement measures (EE);
- Measures to increase the use of renewable energy sources (RES).

Table 33. Renovation measures

Ref. No	Renovation measure	Group of measures	
		EE	RES
1.	Modernisation of heating systems	X	
2.	Modernisation of the system for preparation of hot water	X	
3.	Installation of individual heat metering	X	
4.	Roof/attic overlay insulation	X	
5.	Thermal insulation of façade walls and basement	X	
6.	Glazing of balcony/loggias	X	
7.	House door replacement	X	
8.	Windows replacement	X	
9.	Basement overlays, floor insulation	X	
10.	Measures to ensure the building air tightness	X	
11.	Boiler replacement	X	X
12.	Connecting to DH		X

Ref. No	Renovation measure	Group of measures	
		EE	RES
13.	Installation of a heat pump		X
14.	Installation of solar panels		X
15.	Installation of photovoltaic (PV) cells		X
16.	Installation of recuperation	X	
17.	Installation of wind turbines		X

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

In general, renovation measures targeting specific building elements can be technically implemented both individually and in a complex manner. In the context of the LTRS, when assessing a building as an engineering unit and considering the lessons learned in implementing renovation projects, and the provisions of the Green Course, the Recommendations, the NECP, and other strategic documents, priority is given to complex, essential renovation solutions (deep renovation), combining both energy efficiency and renewable energy efficiency measures.

Accordingly, the assessment of the most effective renovation measures was carried out at the level of packages of measures, rather than individual measures. The measure packages are structured so that each package includes the renovation measures needed to achieve a specific energy performance class ranging from class C to class A++.

Minimum energy performance requirements for buildings of all designation in Lithuania are set out in building code STR 2.01.02:2016 Design and certification of energy performance of buildings. It is important to note that:

- The building code does not provide for specific renovation measures (works) necessary to achieve a higher energy performance class. The energy performance class of a building is determined by the values of technical indicators[12]. The formed packages were evaluated as a complex of renovation measures reaching the values of a specific higher energy performance class. The total average investment value (Chapter 2.2) and energy savings (Chapter 2.3) are determined for each package.
- The building code does not provide for measures for all energy performance classes. However, to promote the use of RES and assess the impact of RES investments on the economic payback of packages, even lower classes of packages were supplemented with the most universally applicable measures for increasing the use of RES in buildings: heat pumps and photovoltaic cells (see the table below).

Although the specific renovation measures required for the achievement of the target EPC may vary depending on the actual condition of the building, the building use, and the technological solutions chosen (for example, façade insulation technology), the implementation of the measures in buildings highlighted below is necessary:

- Energy performance classes B and higher: renovation of a building's heating and hot water system in all buildings.
- Energy performance classes A and A++: installation of a ventilation system with recuperation in administrative, scientific, medical, commercial, cultural, hotel and service buildings.
- Energy performance class A++: installation of a ventilation system with recuperation in all buildings; installation of a heat pump and photovoltaic solar cells in administrative, scientific, medical, commercial, cultural, hotel and service buildings.

Although the installation of a ventilation system with recuperation is necessary to meet the requirements of energy performance class A++, it is recommended to provide for mechanical ventilation systems with heat recovery also in buildings of lower energy performance class. To achieve higher energy performance classes A, A and A+, the requirements for the air tightness of buildings are increasing and air cannot circulate as easily in sealed buildings as in old buildings. As a result, indoor air pollution, CO2 concentration and human well-being, work capacity and health are increasing.

[12] Building energy efficiency indicators C1 and C2, thermal energy consumption for heating the building, estimated specific heat losses of the building envelope, building air tightness indicator, technical indicators of the mechanical ventilation with recuperation system, thermal characteristics of the partitions and interfloor ceilings of the building (part thereof) with autonomous heating systems.

Table 34. The Initial list of renovation packages

Ref. No	*Renovation package*
1.	*Class C*
2.	*Class C + Heat pump (HP)*
3.	*Class C + Heat pump (HP) + Photovoltaic (PV) solar cells*
4.	*Class B*
5.	*Class B + Heat pump (HP)*
6.	*Class B + Heat pump (HP) + Photovoltaic (PV) solar cells*
7.	*Class A*
8.	*Class A + Heat pump (HP)*
9.	*Class A + Heat pump (HP) + Photovoltaic (PV) solar cells*
10.	*Class A+*
11.	*Class A+ + Heat pump (HP)*
12.	*Class A+ + Heat pump (HP) + Photovoltaic (PV) solar cells*
13.	*Class A++*
14.	*Class A++ + Heat pump (HP)*
15.	*Class A++ + Heat pump (HP) + Photovoltaic (PV) solar cells*

Source: The authors of the study to develop the long-term renovation strategy of Lithuania.

In addition, four partial renovation packages have been developed to assess effectiveness of partial renovation:

1. Light renovation: modernisation of heating and hot water systems;
2. façade insulation (up to the values of energy performance class C);
3. insulation of the roof covering (up to the values of energy performance class C);
4. replacement of windows (up to the values of energy performance class C).

The light renovation package includes:

- replacement of old elevator heat points with new automated heat points or renewal of old worn-out automatic heat points which do not automatically maintain the target hot water temperature in the internal hot water supply system of the building;
- replacement of radiators, installation of thermostatic valves, replacement of pipelines, installation of individual heat meters or heat cost allocator system, installation of smart metering;
- replacement and insulation of hot water pipelines, installation of hot water valves in hot water circulation system racks, installation of hot water meters, installation of smart metering;
- balancing heating and hot water systems.

To identify the necessary investments and planned energy savings for buildings with different energy performance levels, 15 primary base renovation packages were further subdivided into 33 final base renovation packages, considering the initial energy performance classes of the buildings eligible for renovation packages (e.g. renovation of buildings in energy performance classes D and B to class A+ will require different investments and different energy savings will be achieved), see the table below.

Table 35. Renovation packages

No	Group		Energy performance class	
			Initial	**Target**
Basic packages				
1	C	Class C	≤D	C
2		Class C + Heat pump	≤D	C
3		Class C + Heat pump + PV solar cells	≤D	C
4	B	Class B	≤D	B
5		Class B + Heat pump	≤D	B
6		Class B + Heat pump + PV solar cells	≤D	B
7	A	Class A	≤D	A
8		Class A + Heat pump	≤D	A
9		Class A + Heat pump + PV solar cells	≤D	A
10		Class A	C	A
11		Class A + Heat pump	C	A
12		Class A + Heat pump + PV solar cells	C	A
13	A+	Class A+	≤D	A+
14		Class A+ + Heat pump	≤D	A+
15		Class A+ + Heat pump + PV solar cells	≤D	A+
16		Class A+	C	A+
17		Class A+ + Heat pump	C	A+
18		Class A+ + Heat pump + PV solar cells	C	A+
19		Class A+	B	A+
20		Class A+ + Heat pump	B	A+
21		Class A+ + Heat pump + PV solar cells	B	A+
22	A++	Class A++	≤D	A++
23		Class A++ + Heat pump	≤D	A++
24		Class A++ + Heat pump + PV solar cells	≤D	A++
25		Class A++	C	A++
26		Class A++ + Heat pump	C	A++
27		Class A++ + Heat pump + PV solar cells	C	A++
28		Class A++	B	A++
29		Class A++ + Heat pump	B	A++
30		Class A++ + Heat pump + PV solar cells	B	A++
31		Class A++	A	A++
32		Class A++ + Heat pump	A	A++
33		Class A++ + Heat pump + PV solar cells	A	A++
Partial packages				
34	Partial renovation	Light renovation	≤D	–
35		Façade insulation	≤D	–
36		Roof overlay insulation	≤D	–
37		Windows replacement	≤D	–

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

2.2. DETERMINING THE NEED FOR INVESTMENT

For each renovation package, the investment needed to implement the package has been calculated and allocated to the investment needs.

The table below provides a summary (average values) of the investments required for the implementation of all the simulated renovation packages. As the price of RES measures depends on the building area of the modelled combination, the exact amount of the investment may vary.

Table 36. Investment in renovation measures (EUR/m²)

No	Package	EPC		Multi-apartment buildings			Private houses	Non-residential buildings
		Before	After	Up to 1 000 m²	1 000–5000 m²	Over 5 000 m²		
Basic packages								
1	C	≤D	C	323	249	186	314	249
2	C + HP	≤D	C	361	300	226	405	317–349
3	C + HP + PV	≤D	C	400	331	251	473	385–416
4	B	≤D	B	331	255	191	322	255
5	B + HP	≤D	B	370	307	231	413	324–356
6	B + HP + PV	≤D	B	408	338	256	481	391–422
7	A	≤D	A	351	271	202	341	271
8	A + HP	≤D	A	381	310	233	414	315–340
9	A + HP + PV	≤D	A	410	334	252	465	361–381
10	A	C	A	316	244	182	307	244
11	A + HP	C	A	355	281	213	382	291–311
12	A + HP + PV	C	A	383	304	232	431	336–355
13	A+	≤D	A+	379	292	218	369	292
14	A+ + HP	≤D	A+	409	331	249	442	337–362
15	A+ + HP + PV	≤D	A+	439	356	268	493	382–403
16	A+	C	A+	341	263	197	332	263
17	A+ + HP	C	A+	380	301	227	407	310–330
18	A+ + HP + PV	C	A+	409	323	247	456	356–375
19	A+	B	A+	307	237	177	299	237
20	A+ + HP	B	A+	342	270	211	367	287–306
21	A+ + HP + PV	B	A+	371	290	232	411	333–356
22	A++	≤D	A++	408	314	235	396	314
23	A++ + HP	≤D	A++	438	353	265	462	357–375
24	A++ + HP + PV	≤D	A++	467	377	284	510	398–415
25	A++	C	A++	367	283	211	357	283
26	A++ + HP	C	A++	406	320	242	427	325–344
27	A++ + HP + PV	C	A++	434	343	262	474	366–384
28	A++	B	A++	330	254	190	321	254
30	A++ + HP	B	A++	365	288	224	388	304–319
29	A++ + HP + PV	B	A++	394	307	246	429	343–364
31	A++	A	A++	297	229	171	289	229
32	A++ + HP	A	A++	363	277	227	355	275–299
33	A++ + HP + PV	A	A++	408	306	263	395	315–342
Partial packages								
34	Light renovation	≤D	–	54	37	31	37	37
35	Façade insulation	≤D	–	126	99	69	99	99
36	Roof overlay insulation	≤D	–	56	25	16	25	25
37	Windows replacement	≤D	–	63	53	51	53	53

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

2.3. DETERMINING THE ENERGY SAVINGS AND CO_2 REDUCTION

Energy savings from renovation measures consist of:

- the reduction in thermal and electrical energy consumption achieved by energy efficiency measures and the corresponding reduction in CO_2 emissions;
- the change in the energy source of production achieved by the measures for renewable energy sources and the corresponding reduction in primary energy consumption and CO_2 emissions.

The value of energy savings from renovation measures was calculated in the following stages:

1. estimated savings in energy consumption (kWh) and CO_2 emissions (kgCO_2);

- estimated thermal and electrical energy savings of energy efficiency package measures;
- estimated changes in thermal and electrical energy of RES renovation measures;
- savings in primary energy and CO_2 emissions calculated by applying the factors provided in STR 2.01.02:2016;

2. prices for energy and CO_2 emissions (EUR/MWh and EUR/tCO_2);
3. estimated value of primary energy savings (1x2).

2.3.1. Savings of primary energy

Primary energy savings are calculated considering:

- the change in thermal and electrical energy consumption achieved by energy efficiency and RES measures;
- the production source of primary energy (type of fuel), i.e. the energy production structure of the building stock (see Chapter 1.2.5);
- primary energy factors (see Chapter 1.2.5).

The table below provides a summary of the achieved primary energy savings of all the simulated renovation packages. The savings depend on the year and area of construction of the building of the particular modelled combination; therefore, average amounts are provided.

Table 37. Primary energy savings from the renovation measures (kWh/m²/year)

No	Package	EPC		Multi-apartment buildings			Private houses	Non-residential buildings
		Before	After	< 1 000 m²	1 000–5000 m²	> 5 000 m²		
Basic packages								
1	C	≤D	C	143	112	88	221	78–143
2	C + HP	≤D	C	169	116	92	254	112–174
3	C + HP + PV	≤D	C	202	122	98	298	139–232
4	B	≤D	B	146	113	95	224	81–147
5	B + HP	≤D	B	171	117	99	256	115–177
6	B + HP + FV	≤D	B	204	122	104	299	143–233
7	A	≤D	A	165	141	111	254	99–164
8	A + HP	≤D	A	186	144	115	278	128–189
9	A + HP + PV	≤D	A	214	148	119	310	148–240
10	A	C	A	49	47	38	59	26–40
11	A + HP	C	A	69	52	46	83	51–77
12	A + HP + PV	C	A	93	58	56	115	71–138
13	A+	≤D	A+	181	146	112	262	105–164
14	A+ + HP	≤D	A+	199	149	116	283	131–189
15	A+ + HP + PV	≤D	A+	223	153	120	313	148–242
16	A+	C	A+	66	53	39	68	26–42
17	A+ + HP	C	A+	82	57	47	89	51–81
18	A+ + HP + PV	C	A+	103	63	57	118	71–140
19	A+	B	A+	56	42	35	41	11–23
20	A+ + HP	B	A+	74	46	42	63	25–68
21	A+ + HP + PV	B	A+	96	51	50	92	42–127
22	A++	≤D	A++	186	148	114	299	93–160
23	A++ + HP	≤D	A++	204	151	117	310	113–190
24	A++ + HP + PV	≤D	A++	226	154	121	326	139–243
25	A++	C	A++	71	54	40	104	16–46
26	A++ + HP	C	A++	87	59	48	116	36–85
27	A++ + HP + PV	C	A++	106	65	58	131	62–141
28	A++	B	A++	62	43	37	78	8–28
30	A++ + HP	B	A++	78	47	43	90	7–72
29	A++ + HP + PV	B	A++	99	52	51	105	33–127
31	A++	A	A++	25	10	6	45	5–25
32	A++ + HP	A	A++	48	27	27	56	5–55
33	A++ + HP + PV	A	A++	77	50	53	72	21–112

No	Package	EPC		Multi-apartment buildings			Private houses	Non-residential buildings
		Before	After	< 1 000 m²	1 000–5000 m²	> 5 000 m²		
Partial packages								
34	Light renovation	≤D	–	41	40	34	54	16–30
35	Façade insulation	≤D	–	53	45	31	118	10–41
36	Roof overlay insulation	≤D	–	5	10	8	13	6–15
37	Windows replacement	≤D	–	13	16	12	32	1–10

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

2.3.2. Reduction of CO_2 emissions

The change in CO_2 emissions is calculated from the result of the reduction in primary energy consumption achieved by energy efficiency and renewable energy measures and the change in the source of production using CO_2 emission factors (see Chapter 1.2.5). The table below provides a summary of the achieved reduction of CO_2 emissions of all the simulated renovation packages. Average values are provided. As the magnitude of the savings depends on the year of construction and the size of the building for the specific combination simulated, the exact value of the savings may vary.

Table 38. Reduction of CO_2 emissions from the renovation measures (kgCO_2/m²/year)

No	Package	EPC		Multi-apartment buildings			Private houses	Non-residential buildings
		Before	After	< 1 000 m²	1 000–5000 m²	> 5 000 m²		
Basic packages								
1	C	≤D	C	19	11	9	32	23–39
2	C + HP	≤D	C	14	10	8	23	19–29
3	C + HP + PV	≤D	C	24	12	10	36	26–47
4	B	≤D	B	19	11	10	32	24–39
5	B + HP	≤D	B	15	11	9	23	19–29
6	B + HP + PV	≤D	B	24	12	10	36	26–47
7	A	≤D	A	20	13	11	33	24–40
8	A + HP	≤D	A	16	13	10	27	21–31
9	A + HP + PV	≤D	A	24	14	11	36	26–47
10	A	C	A	8	5	5	13	12–24
11	A + HP	C	A	5	5	4	6	9–14
12	A + HP + PV	C	A	12	6	7	15	14–31
13	A+	≤D	A+	21	14	11	33	24–40
14	A+ + HP	≤D	A+	18	13	10	28	22–31
15	A+ + HP + PV	≤D	A+	25	14	11	36	26–47
16	A+	C	A+	9	6	5	13	12–24
17	A+ + HP	C	A+	6	5	4	7	9–14
18	A+ + HP + PV	C	A+	12	7	7	15	14–31
19	A+	B	A+	8	5	4	10	7–20
20	A+ + HP	B	A+	5	4	3	4	4–11
21	A+ + HP + PV	B	A+	12	5	6	12	9–27
22	A++	≤D	A++	22	14	11	35	23–41
23	A++ + HP	≤D	A++	19	13	10	32	19–32
24	A++ + HP + PV	≤D	A++	25	14	12	36	26–47
25	A++	C	A++	10	6	5	14	11–24
26	A++ + HP	C	A++	7	5	4	11	6–15
27	A++ + HP + PV	C	A++	12	7	7	15	14–31
28	A++	B	A++	9	5	5	11	6–21
30	A++ + HP	B	A++	6	4	4	8	2–11
29	A++ + HP + PV	B	A++	12	6	6	13	9–27
31	A++	A	A++	6	4	4	8	4–18
32	A++ + HP	A	A++	2	1	0	5	0–8
33	A++ + HP + PV	A	A++	10	7	7	9	7–24
Partial packages								

No	Package	EPC		Multi-apartment buildings			Private houses	Non-residential buildings
		Before	After	< 1 000 m^2	1 000–5000 m^2	> 5 000 m^2		
34	Light renovation	≤D	–	12	6	5	26	19–35
35	Façade insulation	≤D	–	13	6	5	29	20–34
36	Roof overlay insulation	≤D	–	10	3	3	25	18–33
37	Windows replacement	≤D	–	10	4	3	26	19–33

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

2.3.3. Primary energy price (EUR/kWh)

Primary energy price is a derivative calculated from the prices of thermal energy and electricity.

Thermal energy price

The value of the energy saved is determined as the discounted value of the product of the sum of the energy savings and the price over 30 years. The price of thermal energy was assessed based on the average price of district heating in Lithuania, considering projected inflation, in three scenarios.

Table 39. Scenarios for the development of the thermal energy price (EUR/MWh)

No	Scenario	2020	Annual variation	2050
1.	Price level 2020	47.0	+2.5%	85.1
2.	Price level 2019	54.0	+2.5%	97.8
3.	Price level 2015–2016	61.0	+2.5%	110.5

Source: The authors of the study to develop the long-term renovation strategy of Lithuania.

Electricity price

The price of electricity was assessed based on the average price of electricity in Lithuania to household customers, considering projected inflation.

Table 40. Scenarios for the development of the electricity price (EUR/MWh)

No	Scenario	2020	Annual variation	2050
1.	Price level 2020	94.7	+2.5%	171.5

Source: The authors of the study to develop the long-term renovation strategy of Lithuania.

2.3.4. CO2 emissions price

The CO_2 value was assessed based on the ETS carbon price developments (scenarios) published by the European Commission:

Table 41. Scenarios of the EC carbon price developments (tCO_2)

No	Carbon price evolution	2020	2025	2030	2035	2040	2045	2050
1.	Reference (fragmented actions, reference fossil fuel prices)	16.5	20	36	50	52	51	50
2.	Effective technologies (fragmented actions, reference fossil fuel prices)	25	34	51	53	64	92	147
3.	Effective technologies (joint actions, low fossil fuel prices)	25	38	60	64	78	115	190

Source: European Commission

2.4. DETERMINING OTHER SIMULATION PARAMETERS

Simulated combinations

During the simulation, 816 unique combinations were constructed from the following unique building features.

- Building use (17 uses of heated buildings);

- Year of construction (eight periods);
- Energy performance class (six classes);

37 renovation packages were assigned to these building combinations and the financial and economic efficiency indicators were calculated (a total of 8 844 unique combinations), i.e. the same building group is modelled as many times as the different renovation packages can be applied to it.

Other assumptions

Other assumptions used in the calculations:

- assessment period: 30 years;
- discount factor: 4%[13];
- annual inflation: 2.5%;
- all prices VAT excluded;
- useful lives (in years): EE measures – 30 years, heat pump collectors – 30 years, heat pumps (groundwater) – 20 years, photovoltaic solar cells – 20 years, heat pumps (air-water) – 15 years;
- for investments with useful lives shorter than the measurement period, the expected reinvestments;
- the investment to be made in any event (even in the absence of renovation) shall not be assessed.

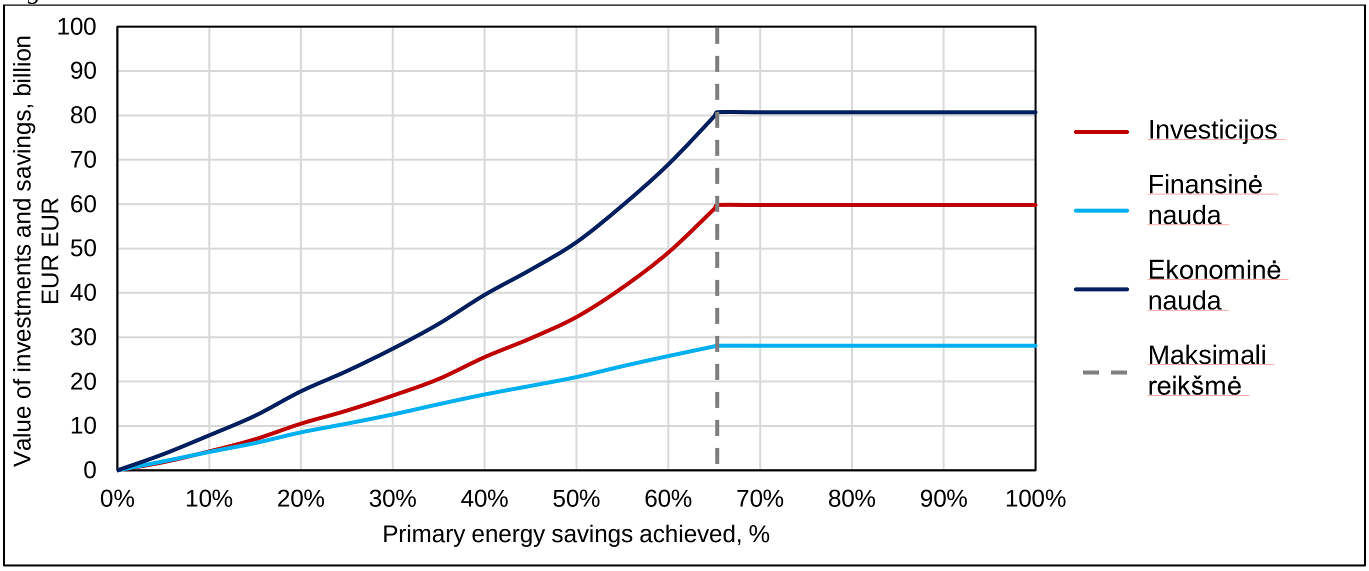
2.5. SIMULATION ALGORITHM

The most cost-effective renovation options at the level of the building stock were determined in the following stages:

1. For each simulation combination, the key indicators are calculated, i.e.:
    - the investment needed to implement the package;
    - the estimated energy savings and their value (financial benefit);
    - the estimated value of the economic benefits (economic benefits);
    - the expected financial and economic returns (the difference between the investment required and its achievable financial and economic benefits over the measurement period).
2. For each simulated combination, it is calculated what financial or economic return is brought by the saved 1 kWh (see the table below).
3. All simulated combinations are arranged according to the return criterion (EUR/kWh) – the highest ranking is assigned to the packages of renovation measures providing the maximum economic benefit.
4. The primary energy savings target (GWh or %) is set at the level of the building stock.
5. Moving from the top of the list of tangled simulation combinations, a list of simulation combinations meeting the primary energy saving target set in step 4 is selected.
6. Changing the energy saving target, i.e. repeating step 4 (every 5%) and step 5, results in a renovation investment and saving curve (see figure below).

[13] The value recommended by the European Commission, see Commission Delegated Regulation (EU) No 480/2014

Figure 15. Economic simulation results



Source: The authors of the study to develop the long-term renovation strategy of Lithuania.

Main simulation results:

- X-axis: primary energy savings to be achieved, %;
- Y-axis: value of investments and energy savings in the assessed period, EUR;
- the 'Investment' curve: the investment (EUR) required to achieve energy savings;
- the 'Financial benefits' curve: the value of energy savings achieved (EUR) (price of energy and CO_2 emissions under the chosen price development forecast scenario);
- the 'Economic benefits' curve: the value of the energy savings achieved and the value of the economic benefits (EUR);
- the point 'Maximum value': maximum savings of primary energy.

The data in the figure above shows this information:

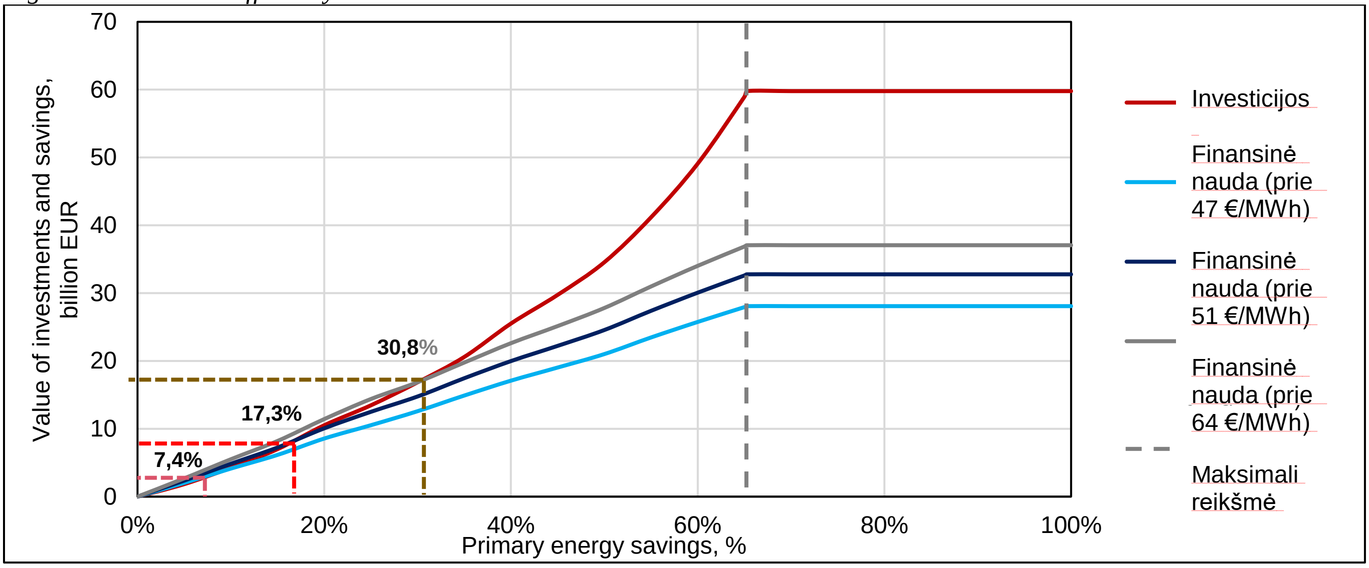
- the point 'Maximum value' (65%) shows the maximum possible primary energy savings after the implementation of the most energy-saving measures, i.e. when the entire building stock reaches energy performance classes A+ or A + +;
- the steepness of the 'Investment' curve reflects the investment intensity required to achieve additional energy savings, i.e. each additional unit of energy savings is more expensive;
- the intersection of the 'Investment' and 'Savings value' curves reveals a point beyond which each additional investment of EUR 1 will bring a financial benefit of less than EUR 1 (to the chosen price level for energy and CO_2 emissions).

2.6. EVALUATION OF FINANCIAL EFFICIENCY

The financial payback assessment simulates the point beyond which each additional EUR 1 invested generates a financial benefit of less than EUR 1 (in terms of primary energy savings and CO_2 emissions value), i.e. finding financially viable savings in primary energy and reduction of CO_2.

The figure below shows the results of the financial efficiency simulation in 3 different heat energy price scenarios.

Figure 16. Financial efficiency simulation results



Source: The authors of the study to develop the long-term renovation strategy of Lithuania.

To summarise the above data, it can be observed that:

- assumptions about energy and CO_2 price trends have a significant impact on financial benefits and recoverability;
- the reliability of the assumptions over a 30-year horizon is not high and accordingly the results of the financial evaluation alone cannot be relied upon;
- in the long term, a scenario of more aggressively rising energy prices is more likely (current level of raw material prices in historic lows, expected reduction of EU subsidies for energy infrastructure).

2.7. ASSESSMENT OF COST-EFFECTIVENESS

The economic payback assessment simulates the point beyond which each additional EUR 1 invested generates less than EUR 1 in economic benefits (financial benefits + value of economic benefits), i.e. finding the economically worthwhile primary energy savings and reduction of CO_2.

The substantial economic benefits of the renovation consist of (for a detailed description, see Chapter 5.3):

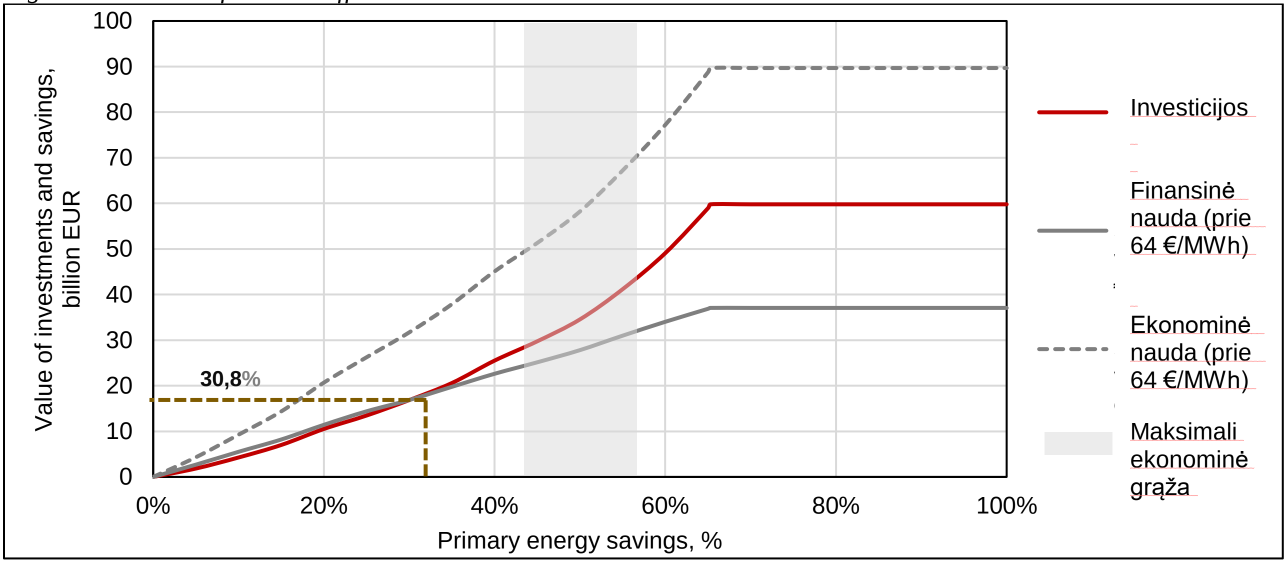
- GDP increase: EUR 1 invested = from EUR 0.88 to EUR 1.06 in GDP increase;
- improved human health and capacity for work: EUR 1 invested = from EUR 0.21 to EUR 0.44 in economic benefits;
- increase in the value of residential housing: the value of residential housing in the five main cities (Vilnius, Kaunas, Klaipėda, Šiauliai, and Panevėžys) increases by up to 15%;
- reduction of NO_x, SO_2, and number of particulate matter: EUR 1 invested = EUR 0.015 in economic benefits.

However, in line with the principles of prudence and conservatism and in order not to distort the results of the modelling by overly optimistic expectations, when assessing cost-effectiveness :

- only one criterion of economic benefits was used – GDP increase (the criterion with the greatest potential to convert into a financial benefit, i.e. real cash flow);
- the value of the criterion used was halved from its lowest value, i.e. EUR 1 invested = EUR 0.5 in GDP increase (considering that the values of the criteria were modelled at the EU level).

The figure below shows the results of the cost-effectiveness simulation in the most significant energy price increase scenario.

Figure 17. Results of the cost-effectiveness simulation



Source: The authors of the study to develop the long-term renovation strategy of Lithuania.

To summarise the above data, it can be observed that:

- Even in a conservative assessment, the economic benefits exceed the value of investments even at the farthest point (i.e. the maximum renovation scenario is also economically viable).
- The maximum economic returns (the difference between economic benefits and investment) at the level of the building stock are in energy savings of 45–55%. The simulation results show that the most cost-effective renovation packages in this zone are:
  - renovation package No 6: Class B + Heat pump (HP) + Photovoltaic (PV) solar cells;
  - renovation package No 9: Class A + Heat pump (HP) + Photovoltaic (PV) solar cells.
- Accordingly, both packages are seen as a cost-effective way of transforming the building stock.

2.8. TECHNICAL CONSTRAINTS

After identifying the most cost-effective renovation package, an analysis of the technical implementation barriers was additionally carried out to assess whether there are any technical (engineering) limitations to the implementation of the envisaged renovation measures.

When examining possible technical limitations, the buildings are divided into individual, multi-apartment, non-residential and industrial buildings, considering the building use, their ownership, and the requirements of STR 2.02.01:2016.

Private houses

Private houses may face technical constraints in achieving the highest energy performance classes due to the lack of air tightness of the building. Classes A and A++ have significantly higher air tightness requirements than buildings in lower classes. In many cases, it may be difficult to reach adequate air tightness requirements in older buildings because of the physical impossibility of sealing critical areas.

Multi-apartment buildings

In multi-apartment buildings, barriers can also be encountered in the case of energy performance class B due to upgrading the hot water system and replacing piping. Replacing piping in apartments can require a lot of coordination with residents. Glazing of all balconies and replacement of windows are also required to achieve higher EPCs. Since part of the population has already changed windows, the practice shows that it is difficult to convince the population to pay for the replacement of windows again, but to certify the building to class A, each window needs a declaration of performance provided by the manufacturer. In some cases, it is difficult to insulate the building envelope due to a thicker thermal insulation layer as additional technical and aesthetic problems, such as window deepening, arise. As in private houses, classes A and A++ have significantly higher air tightness requirements than for buildings in lower classes. Also, it may be technically difficult to meet the air tightness requirements in older buildings.

Other non-residential buildings

Current practice shows that renovation projects for public non-residential buildings (hotels, administrative and special-purpose buildings, educational, health care, cultural, service, trading, catering, recreational, sports, and transport facilities) often aim for class C rather than class B, only because of the difficulties in completely renovating the hot water and heating piping. Glazing of all balconies and replacement of windows are also required to achieve higher EPCs. In some cases, it is more difficult to insulate the building envelope due to a thicker thermal insulation layer, as additional technical and aesthetic problems, such as window deepening, arise. As mentioned before, classes A and A++ have significantly higher air tightness requirements than buildings in lower classes. Also, it may be technically difficult to meet the air tightness requirements in older buildings. After sealing the building to the requirements of class A+ or A++, it is necessary to improve or install new ventilation systems with recuperation. Due to characteristics of the buildings (e.g. ceiling height), it is not possible to install a high-quality and aesthetically acceptable ventilation system with recuperation in some buildings. Although there are ventilation solutions through the wall, this type of system is more common in multi-apartment buildings and is not suitable for buildings requiring large amounts of air supply.

Industrial buildings

Industrial buildings are not subject to significant technical constraints, as these buildings are not subject to regulatory air tightness requirements.

In summary, no significant technical limitations have been identified when renovating buildings to energy performance classes A and B.

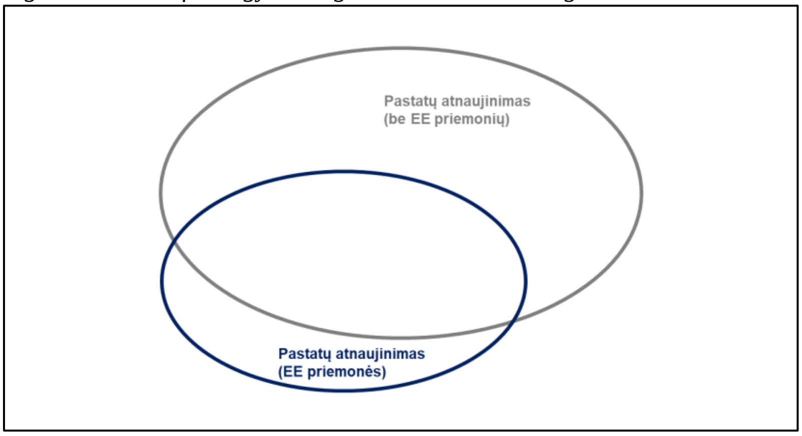
2.9. MOMENT OF INITIATION

An important element of the renovation process is the identification of the right moment to initiate the renovation. Typical triggers for renovation are transactions (e.g. sale of a building, change of use, etc.), renovation (e.g. improvement of the technical condition of a building already planned by the owner, restoration), and natural disaster/incident (e.g. fire, earthquake, flooding).

Considering the willingness of Lithuanian residents to renovate and renovate their housing independently (see Chapter 1.4.4), one of the most significant moments of initiation is the renovation of buildings for other (non-energy saving) reasons. The 'Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU'[14] commissioned by the European Commission reveals that only a quarter of building renovation works currently involve energy-saving measures. Meanwhile, more than 90% of renovation works are carried out by including additional (not only energy efficiency-related) building renovation work, i.e. only 10% of renovations are carried out exclusively for energy saving works (see figure below).

[14] https://ec.europa.eu/energy/studies/comprehensive-study-building-energy-renovation-activities-and-uptake-nearly-zero-energy_en

Figure 18. Use of energy-saving measures in building renovation



Source: Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU

Accordingly, considering the moments of initiation, it may be possible to carry out the renovation in a cost-effective manner due to the economies of scale that can be achieved if the energy-related renovation is carried out at the same time as other necessary work or scheduled renovation.

The following is an overview of the trigger points applicable to each building group.

Private houses

The main moment of initiation of renovation of individual houses is change of ownership of the building. In accordance with the Law of the Republic of Lithuania on Construction, when selling or leasing a building, the owner must transfer a valid energy performance certificate for the building or part thereof to the new tenant or buyer. Potential new owners of the building shall be provided with information on the condition of the building and all renovation needs when performing the energy performance certification of the building required for the transaction. To increase the value of the dwelling, the owner may seek to carry out renovation work on the building (e.g. partial renovation).

Multi-apartment buildings

Residents of multi-apartment buildings choose renovation for many reasons: reduction of heating costs, improvement of aesthetic appearance, increase of comfort level and property value. Particular attention should be paid to the modernisation of multi-apartment buildings in critical condition (through roof, falling wall cladding or bricks, weakened balconies or canopies), in order not only to prevent accidents but also to prolong the life cycle of the buildings.

District renovation may be one of the essential measures for initiating and increasing the pace of multi-apartment renovation. Also, renovating the whole district at the same time can significantly improve the functionality, attractiveness and well-being of the district. District renovation is important to attract more renovation services. District renovation rather than one building at a time could attract major construction companies, which would reduce the cost and increase the pace of renovation. Read more about the district renovation in Chapter 5.2.6.

Other non-residential buildings

Many non-residential buildings are commercial, leased facilities. Building lessors are interested in attracting tenants to the premises, and one of the most important aspects when choosing the place of lease is a modern and energy-efficient building. When changing or trying to keep existing tenants, building owners will have to modernise the managed building and engineering systems, install renewable energy sources to remain competitive in the market.

It is in the interest of the State and municipalities to modernise the buildings they manage to reduce the costs of maintaining the buildings by improving working and comfort conditions.

Industrial buildings

The owners of industrial buildings regularly invest in the modernisation of buildings and the upgrading of engineering systems to optimise the maintenance costs of buildings. As in the case of commercial non-residential buildings or individual houses, the owner of the building will be forced to carry out the energy performance certification of the building during the lease or sale, and to consider the possibilities of retrofitting by increasing the value of the building.

2.10. ESSENTIAL OBSERVATIONS OF THE CHAPTER

- ✓ Considering the financial payback with the current energy prices, financially recouping renovation measures would save only 7.4% (3.0 GWh/year) of primary energy.
- ✓ Considering a possible 30% increase in heat prices, the number of financially recoupable renovation measures would increase, and their energy savings would increase more than 4 times (up to 30.8% or 12.6 GWh/year of primary energy).
- ✓ Assessing the economic payback even in a conservative assessment, all the renovation measures applied would pay off economically, i.e. it is economically worth carrying out the maximum renovation.
- ✓ The maximum economic benefit is achieved by achieving 45–55% (or 16–20 GWh/year) in primary energy savings. This range includes the renovation of the entire building stock to energy performance class B (by applying RES measures) or the renovation of a smaller part of the stock (by assessing the non-peak involvement of the building stock) to energy performance class B and A.
- ✓ In view of the technical constraints, significant difficulties would arise in achieving energy performance classes A and B. When renovating to energy classes A and B, the technical limitations are partial and can be addressed.
- ✓ In summary, the aim of the economic assessment would be to renovate the building stock to energy performance class A or B (by applying RES measures).

3. OVERVIEW OF APPLICABLE BUILDING RENOVATION POLICIES AND MEASURES

3.1. POLICIES AND ACTIONS IN PLACE TO PROMOTE COST-EFFECTIVE DEEP RENOVATION OF BUILDINGS

Article 2a(1)(c) of the EPBD provides that each LTRS shall encompass ‘policies and actions to stimulate cost-effective deep renovation of buildings, including staged deep renovation, and to support targeted cost-effective measures and renovation for example by introducing an optional scheme for building renovation passports;’.

Lithuania’s long-term building renovation strategy is part of the National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030 (NECP). The NECP merged and integrated the provisions, objectives and tasks of Lithuanian national legislation, international commitments, strategies and other planning documents, as well as the implemented and planned measures.

A summary of the measures provided for in the NECP to promote deep renovation of buildings, energy efficiency or wider use of RES in buildings is presented in the table below. To maintain traceability, the same measure codes are maintained as in the NECP.

Table 42. Existing policy measures to promote deep renovation of buildings

Measure	Scope and results/effect envisaged	Implementation period	Responsible authority	Energy savings and cumulative GHG reduction effect
AEI2. Financial support for prosumers (EU support)	Annual increase in RES-E by 0.075 TWh until 2024	2018–2024	Ministry of Energy	–
AEI20. To carry out the assessment of the current situation and further developments in the supply of heat in the decentralised sector	A study has been completed and necessary legislation has been adopted to create a favourable regulatory environment for gradual transition of individually heated households (dwellings) to clean and low greenhouse gas emission technologies or their entry into the DH system	2019–2021	Ministry of Energy	–
EE2. Renovation/modernisation of multi-apartment buildings	To renovate a multi-apartment building to class C and save 40% of energy. By the end of 2030, around 5 000 multi-apartment buildings should be renovated, which means that nearly 500 multi-apartment buildings will be renovated each year.	2021–2023	Ministry of the Environment, BETA	1.9 TWh
EE3. Renovation of public buildings	To renovate a public building to class C and to renovate about 960 000 m2 of public building surface by 2030	2021–2023	Ministry of Energy, Ministry of the Environment	0.19 TWh
EE4. Agreements with energy suppliers on consumer education and consulting	Energy suppliers will ensure the implementation of the scope, and measures of consumer education and consulting provided for in agreements concluded between them or through other persons (including the introduction of smart metering)	2021–2030	Energy suppliers, Ministry of Energy	3 TWh
EE6. Energy saving agreements with energy companies	Energy companies will save energy according to the levels of energy specified in the energy savings agreements (either on their own or through others) by applying cost-effective energy efficiency improvement measures at the final energy customers' facilities (installations, equipment, transport)	2021–2030	Ministry of Energy, energy companies	5.5 TWh

Source: NECP

A brief description of the current policy measures is provided below:

- Measure AEI2: Financial support to prosumers aims to increase electricity production from renewable sources and to turn half of electricity consumers into prosumers by 2050. In January 2020, a larger number of applications than the indicative budget of EUR 4.5 million was decided to increase the budget. Additional calls for support to prosumers are planned for 2020. Nonetheless, the planned budget is not sufficient to reach EUR 34 000 prosumers by 2021 through this measure alone. However, the development of remote solar power plants is likely to achieve this objective.
- Measure EE2: Renovation/modernisation of multi-apartment buildings is expected to reach or nearly reach the target of 2020. However, the scale of the measure is not sufficient to reach the target of 2050, i.e. to reduce the energy costs of the building stock by at least 60%, let alone to make the building stock energy neutral. At the current average renovation rate, the renovation of all multi-apartment buildings would take more than a hundred years.

- Measure EE3: Renovation of public buildings is marketable and relevant, financed by the EU funds for 2014–2020.
- Measure EE4: Agreements with energy suppliers on consumer education and consulting is necessary and appropriate, but no objective assessment of savings is possible. The effectiveness of the measure is currently difficult to assess, but according to a survey conducted by Spinter Research, 77% of respondents living in apartment blocks built before 1993 support the renovation of apartment blocks and would participate in the renovation of their building under the right circumstances, compared to 62% of the residents of apartment blocks to be renovated in 2018. This shows that the population's awareness and acceptance of the importance of energy efficiency is growing, but it does not prove the effectiveness of this measure.
- Measure EE6: Energy saving agreements with energy companies. The agreements with the energy companies to achieve 1 TWh of energy savings were signed in 2014–2019, and two out of three energy companies, Amber Grid, AB and Litgrid, AB, have achieved their goals; however, power distribution operator ESO, AB lags behind the target by almost a third. This is due because the savings achieved during the renovation of substations and the network have not been offset, as these savings had not been achieved at the end user level. The discrepancy was also increased by differences in the calculation methodology.

3.2. POLICIES AND ACTIONS IN PLACE FOCUSED ON TARGETED RENOVATION SEGMENTS

Article 2a(1)(d) of the EPBD provides that each LTRS shall encompass ‘an overview of policies and actions to target the worst performing segments of the national building stock, split-incentive dilemmas and market failures, and an outline of relevant national actions that contribute to the alleviation of energy poverty;’.

3.2.1. Worst performing segments of the building stock

Currently, the buildings with the lowest energy efficiency are renovated as a matter of priority by implementing the Programme for the renovation (modernisation) of multi-apartment buildings.

The implementation of the Programme started in 2005. Initial conditions for participation in the Programme for the renovation/modernisation of multi-apartment buildings (the ‘Programme’):

- only multi-apartment houses (three- and multi-apartment houses, which may include non-residential premises — commercial, administrative, catering, etc.) are eligible for the Programme;
- multi-apartment buildings must be constructed in accordance with the technical construction regulations in force before 1993.

to prioritise and accelerate the process of renovation of buildings with the lowest energy efficiency, in 2013 municipalities were recommended to prepare energy efficiency improvement programmes. In implementing this recommendation, municipalities have selected the most inefficient multi-apartment buildings in their territories, which consume more than 150 kWh/m^2 of thermal energy per year (2 329 multi-apartment buildings).

Multi-apartment buildings selected by municipalities and the most energy-efficient shall be assigned Programme administrators, who shall implement the renovation of these multi-apartment buildings. According to the report of the National Audit Office of Lithuania[15], by July 2019, 1 319 of the 2 329 multi-apartment buildings had been modernised in accordance with the investment plans for the most inefficient multi-apartment buildings drawn up by the municipalities (i.e. 56.6%). The rest, i.e. 1 010 multi-apartment buildings were not renovated because:

- 81.4% (822 out of 1 010) prepared plans were not approved by the owners of the apartments and other premises, i.e. they were not in favour of the modernisation;

[15] Public Audit Report on the Renovation (Modernisation) of Multi-apartment Buildings, the National Audit Office of Lithuania

- 18.6% (188 out of 1 010) accounted other reasons (non-legalised ownership of apartments, non-remuneration of debts for public utilities, etc.).

Accordingly, it can be stated that an essential condition for the smooth modernisation of multi-apartment buildings is the active and constructive involvement of the owners.

3.2.2. Different incentive dilemmas and other market failures

Within the scope of the LTRS, the term 'market failure' refers to several problems that may slow down the transformation of the building stock and exploit the potential for cost-effective energy savings. It can be understood as a set of disturbances and barriers that prevent the renovation process from taking place or at an insufficient pace.

Different incentive dilemmas

Different incentives arise between the owner and the tenant or owners of a building when the party paying for the modernisation of energy infrastructure or measures to ensure greater efficiency is unable to reap the full benefits and achieve savings.

Article 19 of the EED requires Member States to 'evaluate and if necessary take appropriate measures to remove regulatory and non-regulatory barriers to energy efficiency, without prejudice to the basic principles of the property and tenancy law of the Member States, in particular as regards: (a) the split of incentives between the owner and the tenant of a building or among owners, with a view to ensuring that these parties are not deterred from making efficiency-improving investments that they would otherwise have made by the fact that they will not individually obtain the full benefits or by the absence of rules for dividing the costs and benefits between them, including national rules and measures regulating decision- making processes in multi-owner properties;'

The following main types of different incentive dilemmas are distinguished:

a) the dilemma of user incentives;
b) the dilemma of efficiency incentives;
c) the dilemma of incentives for different owners/users;
d) temporary incentive dilemmas.

The specific type of split incentive dilemma is directly related to the types of building and building user, see the table below.

Table 43. Classification of split incentive dilemmas

Building type	**The user is the owner**	**The user is a tenant**
Single-family building	None split incentive dilemmas	- The dilemma of user incentives - The dilemma of efficiency incentives
Multi-apartment building	The dilemma of incentives for different owners	- The dilemma of different user incentives - The dilemma of user incentives - The dilemma of efficiency incentives

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

(a) The dilemma of user incentives

The dilemma of user incentives typically arises when the user of a building is a tenant whose energy payments are independent of actual consumption, i.e. the rent is fixed and includes all utility charges. In this case, the tenant has no direct economic incentive to rational and efficient use of energy.

(b) The dilemma of efficiency incentives

The dilemma of efficiency incentives typically arises when a tenant pays for energy consumption but has a limited opportunity to motivate the homeowners to invest in energy efficiency improvement measures. Additional favourable conditions for the formation of a dilemma are when the demand in the rental market exceeds supply, the price of energy is not high, and the market standard is short-term (one to two years) rental contracts. In such a case, even at the request of the lessee, the owner of the dwelling is not financially motivated to invest in energy-saving measures since the energy costs are passed on to the lessee and the investment will not increase the expected financial return from the lease.

(c) The dilemma of incentives for different owners/users

The dilemma of incentives for different owners is an additional barrier to situations where the building is used by more than one owner and/or tenant. Different interests of owners (tenants), expectations, financial situation and similar factors make it difficult to make a joint decision satisfying most and necessary for the renovation process.

(d) Temporary incentive dilemmas

Temporary incentive dilemmas typically arise when a tenant or owner does not know how long they will use a building or knows that they will only use a building in the short term. Accordingly, it is not interested in investing or participating in renovations or any other complex process that requires time, attention, and investment. Temporary incentive dilemmas are generally solved by a change in the building owner or the current owner's plans for the use of the building.

Policies and actions in place

It is important to note that the situation where the user of the building is the owner of the building is characterized by only one type of different incentive dilemma, the dilemma of incentives for different owners. All other types of split incentive dilemmas are specific to the situation where the user of the building is not the owner of the building, i.e. in the relationship between the lessor and the lessee.

According to Eurostat, most of building users in Lithuania are also building owners (89.9% in 2018)[16]. Accordingly, the dilemmas of different incentives related to the landlord-tenant relationship should be assessed as of limited significance, for the management of which general sanctions should be applied, i.e. informing consumers about the benefits of saving, the detriment of irrational energy consumption, etc.

The risk of a dilemma of incentives for different owners should be assessed as relevant. Some apartment owners are not only sceptical about the benefits of renovation, but also do not identify themselves as the owner of the common property of the building (responsible for that property).

The risk of the dilemma of incentives for different owners is also confirmed by the results of the audit carried out by the National Audit Office of Lithuania in 2020 to assess whether the process of renovation (modernisation) of multi-apartment buildings is being carried out effectively. The audit report[17] states that 35% (822 out of 2 329) of the projects had not been implemented by July 2019 due to owners' disapproval of the renovation. Therefore, the smooth modernisation of multi-apartment buildings requires the involvement of the owners.

The dilemma of incentives for different owners in Lithuania is solved by applying both legal and publicity measures in a complex way, as highlighted below.

- A decision on renovation is sufficient for 50% plus one vote (the minimum majority): in accordance with Article 4.85 of the Civil Code, 'Decisions regarding the possession and use of parts of common use shall be taken by most of votes of the owners of flats and other premises', i.e. if more than 50% of the owners of the apartments and other premises approve the renovation of the multi-apartment building, a decision on the renovation of the multi-apartment building shall be adopted and established by the minutes of meeting.
- The socially disadvantaged persons are supported by the state: the socially disadvantaged persons entitled to compensation for heating receive 100% of the state support for the preparation of technical documentation, as well as for covering the credit and interest taken for construction and contract work. For them, renovation costs absolutely nothing.
- All target groups of owners are subject to publicity and information measures[18].

[16] https://appsso.eurostat.ec.europa.eu/nui/submitViewTableAction.do
[17] https://www.vkontrole.lt/pranesimas_spaudai.aspx?id=25019
[18] http://www.betalt.lt/doclib/eqs6hohgh1wu2ebycsbsmtbg9f2xmspu

Other market failures

The impact assessment[19] accompanying the proposal for a revision of the EPBD sets out other typical market failures related to investments in energy efficiency improvement measures for buildings.

a) Weaknesses in the information on the benefits of renovation

Energy consumers often do not have enough information (they are not aware of existing technologies for saving energy)[20]. Lack of information, due to lack of energy education, training and, at the same time, motivation, contributes to insufficient investments in renovation measures. End-users (building owners) are often unaware of the benefits of introducing energy efficiency measures.

Currently, in Lithuania, information on the benefits of renovation is carried out within the scope of individual support measures. There is also a broader communication under the BETA 2016–2020 public awareness campaign strategy.

Energy consumer education and consultation agreements are an additional measure that is currently being implemented. The use of education and counselling measures is one of the ways to increase energy efficiency by promoting awareness among energy end-users and influencing their behaviour and habits. Energy supply companies have been carrying out education and consultation activities for final consumers since 2017 and energy savings of more than 200 GWh are already being calculated. The education and consultation activities are continuous and are expected to continue after 2020 in the framework of the implementation of the energy efficiency improvement policy.

b) Insufficient pace of renovation due to unfavourable economic cycle

In the short term, the current economic cycle, which is uncertain due to the impact of COVID-19, may be detrimental to the implementation of the LTRS measures due to the reduced willingness and ability of building owners to invest. However, from a long-term perspective, if the support package is properly designed, the renovation breakthrough may become an impulse both for the construction sector and the national economy as a whole.

On the other hand, economic stimulus measures could include the promotion of renovation projects (e.g. renovation of apartment blocks is part of the Economic Stimulus and Coronavirus (COVID-19) Mitigation Action Plan).

c) Lack of attractive financial instruments

Financial measures related to the renovation of buildings shall respond directly to the support measures carried out. The administration of funding measures is carried out by the Public Investment Development Agency (VIPA). The following is a list of the measures taken:

- **Loans for the installation of solar power plants.** The VIPA grants loans that may finance the applicant's investments in the installation and/or acquisition of a part of a power plant using renewable resources that meets the requirements set for producing consumers, as well as the development of remote solar parks.
- **Loans for small renovation projects.** The Energy Efficiency Financing Platform (EEFP), established by VIPA and the ESO, AB, provides long-term loans to administrators of common facilities for the implementation of small-scale renovation projects. Light renovations are renovation projects for multi-apartment buildings that help to increase energy efficiency by investing in one or more energy efficiency measures (e.g. renovation of heating systems, insulation of the roof or ceiling in the shelter, windows, etc.).
- **Funds for the modernisation of multi-apartment buildings.** Lithuania has two preferential loan funds for the renovation (modernisation) of multi-apartment buildings: The Multi-apartment Building Modernisation Fund (DNMF) managed by VIPA, and the Jessica II fund of funds managed by the European Investment Bank (EIB). The funds grant loans in accordance with the programme approved by

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52016SC0414&from=EN

[20] Assessment commissioned by the Ministry of Finance in May 2018, 'Ex-ante assessment of energy efficiency'

the Government of the Republic of Lithuania, the aim of which shall be to reduce the consumption of thermal energy, rational use of energy resources, to ensure the efficient use of housing, to improve the living environment and the quality of life of the population.

- **Public buildings of the central government.** The measures for the modernisation of public buildings of the central government are implemented from the Energy Efficiency Fund (ENEF), financed from the European Regional Development Fund, the aim of which is to increase the efficiency of energy consumption for the heating and lighting of public buildings, to ensure the efficient use of the State funds allocated by the Republic of Lithuania for the improvement of the energy efficiency of public buildings and the operation of public buildings, to reduce greenhouse gas (CO_2) emissions into the atmosphere, and to ensure the compliance of the infrastructure of public buildings with the requirements of the hygiene norm. VIPA provides preferential loans for the renovation of the public buildings of the central government, and the financing model of the repayable subsidy can be used.
- **Municipal building stock.** The Municipal Public Buildings Modernisation Measure is funded by the European Regional Development Fund and private funding with the aim of increasing the efficiency of energy consumption for heating and lighting in municipal public buildings, ensuring the efficient use of funds allocated for energy efficiency improvements and maintenance of municipal public buildings, reducing greenhouse gas (CO_2) emissions, and ensuring the compliance of the infrastructure of municipal public buildings with the hygiene standards.

It is important to note that the European Court of Auditors, in its Special Report of 2020[21], recognised the use of financial instruments for energy efficiency upgrades to multi-apartment buildings in Lithuania as good practice. Accordingly, the policy applied in this segment is effective in achieving the objectives developed so far; however, it needs to be adapted to the new objectives.

d) Insufficient detail of the building stock

There is a lack of systematically collected information on the characteristics of the building stock and energy consumption.

e) Insufficient use of smart technologies.

The measures taken are discussed in Chapter 3.4.5.

3.2.3. Policies and actions in place to address energy poverty

Energy poverty arises from four main factors:

1. inefficient energy consumption;
2. high energy prices;
3. low household incomes;
4. lack of awareness among consumers of the potential for reducing energy poverty.

The transformation of the building stock envisaged by the LTRS will have a direct impact on Factors 1 and 4 and an indirect impact on Factor 2.

The level of energy poverty can be measured by six indicators:

- the share of persons living in households who cannot afford sufficient heating due to lack of money;
- the share of household costs spent on electricity and heat;
- the share of households whose household maintenance costs exceed 40% of disposable income;
- the share of disposable income and household maintenance costs;
- the share of households with overdue debts for utilities;
- the share of households whose living conditions are inadequate (roof leaks, damp walls or foundations, and rotten window frames).

[21] https://op.europa.eu/webpub/eca/special-reports/energy-efficiency-11-2020/lt/index.html

The share of persons living in households who cannot afford sufficient heating due to lack of money

In Lithuania, the share of persons living in households who cannot afford sufficient heating due to lack of money has been declining since 2011, reaching 26.7%. Compared to other EU countries, the share of the population is not able to sufficiently heat their homes in Lithuania almost ~3 times higher than the average of the EU countries (see the table below).

Table 44 The share of persons who cannot afford sufficient heating due to lack of money (%)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
The share of persons living in households who cannot afford sufficient heating due to lack of money (LT)	25.2	36.2	34.1	29.2	26.5	31.1	29.3	28.9	27.9	26.7
The share of persons living in households who cannot afford sufficient heating due to lack of money (EU)	9.9	10.3	11.2	10.8	10.4	9.6	9	8.1	7.6	n.d.

Source: Eurostat

The share of household costs is spent on electricity and heating

Apart from the amount of income, relatively high expenditure on heating is one of the reasons why such a large part of households in Lithuania cannot afford sufficient heating. On average, electricity costs accounted for up to ten times the EU 27 average in 2015. Meanwhile, Lithuania's share of household expenditure on electricity is one tenth lower than in the EU. The share of expenditure on heat is partly determined by the fact that in a large part of Europe winters are warmer than in Lithuania, therefore heating of buildings is less necessary, even if their energy efficiency is similar to that of buildings in Lithuania. Data on the share of household expenditure on electricity and heat in Lithuania and the EU 27 are presented in the table below.

Table 45. The share of household costs is spent on electricity and heating (%)

Indicator	*Country*	*2010*	*2015*
The share of household costs spent on electricity	*Lithuania*	*0.70%*	*0.74%*
	EU 27	*0.93%*	*0.85%*
The share of household costs spent on heating	*Lithuania*	*1.04%*	*1.40%*
	EU 27	*0.21%*	*0.14%*

Source: Eurostat

The share of households whose household maintenance costs exceed 40% of disposable income

Rapid wage growth, falling energy resource prices and the growing use of biofuels in the district heating sector also led to a rapid decrease in the share of households whose household maintenance costs exceed 40% of disposable income in Lithuania. Over the period 2010–2018, this indicator halved, while in the rest of the EU this indicator remained more or less stable, when it was the same in Lithuania and the EU. This change also confirms that, although heating costs in Lithuania are higher than in the EU, the colder climate has a significant impact on this.

Table 46. The share of households whose household maintenance costs exceed 40% of disposable income (%)

	2010	2011	2012	2013	2014	2015	2016	2017	2018
The share of households whose household maintenance costs exceed 40% of disposable income in Lithuania	10.6	11.1	8.9	8.2	7.1	9.1	7.8	7.2	5.6
The share of households whose household maintenance costs exceed 40% of disposable income in EU 28	10.8	11.4	11.0	11.1	11.6	11.4	11.1	10.4	10.3

Source: Eurostat

The share of disposable income and household maintenance costs

Although in Lithuania household expenditure on heating is relatively higher than in the EU, the share of total expenditure related to household maintenance costs compared to disposable income was lower than in the entire 2010–2018 period. The share of disposable income for household maintenance costs in Lithuania decreased by a quarter during this period. This was influenced by three factors: rapid wage growth (6.1% per year), decreasing fuel prices (gas 6.5%, biofuels 4.0% per year) and increased use of biofuels in district heating (from 19% in 2010 to over 70% in 2019). Renovation contributed in part to the improvement of this indicator but was not an essential factor. The data on the share of household maintenance costs in disposable income in Lithuania and the EU 28 in 2010–2018 are presented in the table below.

Table 47. The share of disposable income for household maintenance costs (%)

	2010	2011	2012	2013	2014	2015	2016	2017	2018
The share of disposable income for household maintenance costs in Lithuania	20.3	21.8	20.1	19.5	18.6	19.0	17.2	16.3	14.8
The share of disposable income for household maintenance costs in EU 28	22.4	22.4	22.0	22.3	22.7	22.6	22.0	21.4	21.0

Source: Eurostat

The share of households with overdue debts for utilities

The relatively heavy burden of heating bills on households is also illustrated by the share of households with overdue debts for utilities, which remains around 10% with fluctuations in Lithuania. (9.2% in 2018). Although this is lower than the EU average, the analysis of this indicator is much more important for the trend than the level and comparison with other EU countries. The inhabitants' disciplined, utility billing features lead to significant differences between countries. Accordingly, debts for utilities are gradually decreasing in Lithuania, which may indicate that the burden of utility bills is decreasing or that household income is increasing. More detailed data on household debts for utilities are presented in the table below.

Table 48. The share of households with overdue debts for utilities (%)

State	2010	2011	2012	2013	2014	2015	2016	2017	2018
Greece	18.8	23.3	31.8	35.2	37.3	42.0	42.2	38.5	35.6
Bulgaria	31.6	28.6	28.4	34.0	32.9	31.4	31.7	31.1	30.1
Serbia				36.7	41.4	34.8	34.8	18.1	28.4
Croatia	28.0	27.5	28.9	30.4	29.1	28.7	25.3	21.0	17.5
Romania	26.5	27.3	29.7	29.7	21.5	17.4	18.0	15.9	14.4
Slovenia	18.0	17.3	19.3	19.7	20.3	17.5	15.9	14.3	12.5
Latvia	22.5	23.4	22.4	20.7	19.6	16.7	13.2	11.9	11.6
Hungary	22.1	22.7	24.4	25.0	22.3	19.4	16.2	13.9	11.1
Lithuania	10.9	11.8	12.6	13.2	10.4	8.4	9.7	7.9	9.2
Ireland	12.6	14.8	17.4	17.9	18.2	15.2	11.9	9.9	8.6
Slovakia	9.6	6.4	5.8	5.9	6.1	5.7	5.7	5.5	7.9
Finland	6.9	7.8	7.9	8.4	7.9	7.5	7.7	7.8	7.7
Spain	7.5	5.7	7.5	8.3	9.2	8.8	7.8	7.4	7.2
Estonia	11.0	11.8	10.9	10.4	10.0	7.9	7.9	6.3	6.5
France	7.1	7.1	6.7	6.2	6.3	5.9	6.1	6.1	6.4
Poland	13.9	12.9	14.1	14.0	14.4	9.2	9.5	8.5	6.3
United Kingdom	5.6	5.0	8.9	8.7	7.2	7.0	5.7	5.0	5.4
Denmark	3.2	3.4	3.5	3.6	4.6	3.4	2.5	3.5	5.1
Belgium	5.8	6.0	6.1	5.0	5.8	5.1	5.0	4.1	4.5
Italy	11.2	12.0	11.7	11.9	12.2	12.6	8.9	4.8	4.5
Portugal	6.4	6.7	6.3	8.2	8.5	7.8	7.3	5.6	4.5
Switzerland	4.8	3.5	3.6	3.0	4.2	3.6	4.5	3.6	4.1
Luxembourg	2.1	2.2	2.2	3.1	3.2	2.4	4.0	1.7	3.6
Germany	3.5	3.9	3.4	3.6	4.2	4.0	3.0	2.8	3.0
Norway	6.3	6.9	4.6	4.5	3.1	3.2	2.4	3.0	2.7
Austria	4.4	4.0	3.8	4.6	3.5	3.5	4.2	3.6	2.4
Sweden	5.2	4.6	4.3	4.7	3.6	3.2	2.6	2.2	2.2
Czech Republic	4.2	4.3	4.1	4.0	4.7	3.0	3.0	2.1	2.1
Netherlands	2.1	2.4	2.3	2.4	3.0	2.7	2.0	2.1	1.5
EU average	**9.1**	**9.0**	**9.9**	**10.2**	**9.9**	**9.1**	**8.1**	**7.0**	**6.6**

Source: Eurostat

The share of households whose living conditions are inadequate

Living in buildings whose living conditions are inadequate is not only uncomfortable and can have negative health consequences, but heating such buildings, even if insufficiently heated, to hygiene standards is expensive and can have a significant impact on household indebtedness. In Lithuania, the share of such households decreased from 19.2% to 14.8% in 2010–2018. In 2018, it was close to the EU average of 13.9%. Renovation of multi-apartment buildings is one of the factors improving these statistics but increasing income has also allowed households to carry out their own repair works addressing the basic problems of buildings. Accordingly, the lack of financing measures for the renovation of individual houses (at least for essential structures) in rural areas can severely limit the possibilities to reduce the share of households whose living conditions are below the EU average.

Table 49. The share of households whose living conditions are inadequate, 2010–2018 (%)

State	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Portugal	21.9	21.3	22	31.9	32.8	28.1	30.5	25.5	26.9
Latvia	24.7	26.0	28.2	27.7	27.5	24.4	21.9	22.8	23.5
Slovenia	32.4	34.7	31.5	27	29.9	26.9	23.8	22	22.7
Hungary	24.2	22.1	24.7	26.7	26.9	25.4	26.7	24.8	22.5
Luxembourg	17.2	15.5	17.1	15.3	15	14.4	18.7	17.4	18.3
Belgium	19	21.2	18.7	18.1	17.5	18.2	19.2	18.4	17.9
United Kingdom	15	15.9	17.2	15.9	16.6	14.8	16.4	17	17.6
Denmark	8	16.3	17.6	16.6	15	16.1	15.9	14.9	16.4
Spain	21.8	16.1	12	16.7	17.1	15.2	15.9	11.5	15.9
Netherlands	15.2	14.6	16.2	15.6	15.8	15.7	16.3	13.5	15.8
Lithuania	19.2	19	17.6	19.9	18.9	17	18.2	15.7	14.8
Estonia	18.8	19.2	19.4	17.5	15.9	13.4	13.9	13.9	13.6
Germany	13.3	13.7	13.5	13.1	12.3	12.8	13.1	12.5	13.4
Italy	20.5	23.4	21.4	22.9	25	24.1	21	16.1	13.2
Bulgaria	15.4	14.9	13.8	12.9	13.2	12.9	12.3	12.2	13
Greece	17.1	15.3	14.7	14	13.7	15.1	14.7	13.5	12.9
France	12.5	10.9	12.8	12.8	13.4	12.6	14	11.1	12.7
Ireland	12.6	11.1	13	14.3	14.5	13.6	13.3	12.6	11.9
Poland	15.6	11.5	10.5	10.1	9.2	11.9	11.6	11.9	11.6
Austria	14.8	13.9	11.8	12.5	10	11.7	11.2	11.9	10.4
Romania	18.7	18.1	15.5	16.2	13.6	12.8	13.3	11.1	10.1
Switzerland	8.9	10.6	12.8	11.5	11.3	11.9	12.7	12.2	9.8
Sweden	8	8.7	7.8	7.7	7.7	7.7	7.4	7	7.8
Czech Republic	11.8	11.9	10.5	10	9.2	8.9	8.2	8	7.7
Malta	12.1	10.2	10.8	11.7	10.9	10.1	9.1	8.4	7.1
Norway	7.7	7.6	8.2	7	6	6.8	5.9	5.6	6.8
Slovakia	5.8	7.8	8.8	7.5	7	6.3	6.2	6.7	5.1
Finland	5	5.7	6	5.2	5	4.4	4.7	4.2	4.6
EU average	**16.1**	**15.6**	**15.1**	**15.6**	**15.7**	**15.2**	**15.4**	**13.3**	**13.9**

Source: Eurostat

Policies and actions in place

The existing policy measures aimed at reducing energy poverty can be classified into the following main groups:

- universal measures aimed at increasing revenues;
- universal energy policy measures (solutions common to the entire energy sector, aimed at reducing costs and improving efficiency);
- targeted measures to reduce energy poverty:
  - socio-economic measures (e.g. compensation for heating costs for low-income earners);
  - measures targeting a particular housing segment (e.g. multi-apartment renovation programme);
  - energy-specific measures (energy-specific concessions);
  - measures targeting specific areas/regions.

3.3. POLICIES AND ACTIONS IN PLACE FOCUSED ON PUBLIC BUILDINGS

Article 2a(1)(e) of the EPBD provides that each LTRS shall encompass 'policies and actions to target all public buildings;'.

The table below shows the measures (based on the measure codes specified in the NECP) to promote energy efficiency improvements in public buildings.

Table 50. Existing policy measures to promote energy efficiency improvement in public buildings

Measure	**Scope and results/effect envisaged**	**Implementation period**	**Entities responsible for implementing the policy**	**Energy savings in TWh, and cumulative GHG reduction effect, in ktCO$_2$-eq/year 2021–2030**
EE3. Renovation of public buildings	To renovate a public building to class C and to renovate about 960 000 m^2 of public building surface by 2030	2021–2023	Ministry of Energy, Ministry of the Environment	0.19 TWh
EE4. Agreements with energy suppliers on consumer education and consulting	Energy suppliers will ensure the implementation of the scope, and measures of consumer education and consulting provided for in agreements concluded between them or through other persons (including the introduction of smart metering)	2021–2030	Energy suppliers, Ministry of Energy	3 TWh
EE6. Energy saving agreements with energy companies	Energy companies will save energy according to the levels of energy specified in the energy savings agreements (either on their own or through others) by applying cost-effective energy efficiency improvement measures at the final energy customers' facilities (installations, equipment, transport)	2021–2030	Ministry of Energy, energy companies	5.5 TWh

Source: NECP

3.4. NATIONAL INITIATIVES TO PROMOTE SMART TECHNOLOGIES AND SMART BUILDING MANAGEMENT

Article 2a(1)(f) of the EPBD provides that each LTRS shall encompass 'an overview of national initiatives to promote smart technologies and well-connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors;'.

The following key documents are currently in place to provide national policy guidance for the promotion of smart technology and connected buildings and communities, as well as skills and education in the construction and energy efficiency sectors:

- National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030[22].
- National Energy Independence Strategy[23].
- Smart Specialisation Strategy[24].

[22] https://ec.europa.eu/energy/sites/ener/files/documents/lt_final_necp_main_en.pdf
[23] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.429490/asr
[24] https://strata.gov.lt/en/smart-specialisation

- The Lithuania 2030 Strategy and the implementing documents: the National Progress Programme and the National Progress Plan for 2021–2030[25].

The objectives listed in the National Energy and Climate Action Plan of the Republic of Lithuania for 2021–2030 are related to those of the National Energy Independence Strategy and the Smart Specialisation Strategy and are therefore not covered separately.

3.4.1. Initiatives included in the National Energy Independence Strategy

One of the strategic directions envisaged in the National Energy Independence Strategy is the participation of the country's businesses in pursuance of energy progress (innovation). In this area, the goal has been set that from a country importing energy technologies, Lithuania needs to become a country creating and exporting energy technologies. The aim is for Lithuania to become a centre of information technology and cyber security solutions for energy, biomass and biofuel technology, solar and wind energy technology, geothermal technology, energy market development, improvement of electricity system operation, development of new electricity system management methods and implementation of energy projects.

Considering the specifics and needs of the Lithuanian energy sector, strategic goals, and the existing and desired competences, the following priority directions for energy research and development have been identified related to the efficient energy use, and the RES use in the buildings sector:

- the planning of the future development of the energy sector, energy economics;
- the modernisation of existing energy production technologies based on new challenges and requirements;
- the development of new energy production and storage technologies with low GHG and air pollutant emissions and resilience to climate change and their integration into the network; as well as integration into the EU strategic value chains;
- technologies using local energy generation and renewable energy sources;
- technologies relating to distributed generation, smart networks, production, and the use of new promising energy types.

The Lithuanian National Energy Independence Strategy also stipulates that, to achieve the development of energy innovation, and the use of energy expertise and the results of research and development in other areas of the economy as well as increased export and opening of new businesses in the country, the following will be undertaken:

- increasing synergies among science and research institutions, energy companies and engineering companies by promoting various forms of cooperation using investments from the EU research and innovation programme Horizon 2020, national and other programmes, developing digital energy innovations and improving technologies in Lithuanian energy sector, thus strengthening the ecosystem of scientific research and innovation in Lithuania;
- to achieve closer cooperation between energy companies and educational institutions, partnership-support programmes for energy companies and engineering companies are drawn up to encourage cooperation by developing and deploying digital energy innovations and improving technologies;
- encouraging the development of new energy production technologies, including RES, distributed energy generation and smart grids, and their integration into the network;
- development, production and export of technologies for the production and use of local energy resources;
- promotion of IT solutions for optimising the energy sector and their testing in Lithuania, support for the export of such products.

3.4.2. Initiatives included in the Smart Specialisation Strategy

[25] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/c1259440f7dd11eab72ddb4a109da1b5?jfwid=-whxwii77y

Smart Specialisation Strategy 2014–2020 (final targets to be set in 2023) was approved in 2014. One of the seven priorities for research, development and innovation (RDI) in this programme is relevant to the buildings sector. The priority 'Energy and sustainable environment' includes the rapid development of alternative energy sources, alternative fuels and energy-saving technologies, which would increase the energy efficiency of final consumption, promote Lithuania's competitiveness in the field of clean energy technologies, and help to discover the potential for growth and job creation. Implementation subjects for the of the priority 'Energy and sustainable environment':

- strengthening the interoperability of distributed and centralised generation, networks and the energy efficiency system;
- meeting the needs of existing and new end-users, strengthening energy efficiency and smartness;
- the development of the use of renewable biomass and solar energy sources and the recycling of waste to obtain energy.

In total, the state allocated EUR 679 million to the Smart Specialisation Programme for the period 2014–2023 (including EU structural support). In addition, it is planned that private business investments in the field of research and development will amount to approximately EUR 260 million. EUR 25.97 million have been allocated to the measure 'Energy and sustainable environment'.

3.4.3. Initiatives included in the National Progress Plan 2021–2030

The National Progress Plan 2021–2030 includes the objective to shift to sustainable economic growth based on scientific knowledge, advanced technologies and innovation and to increase the international competitiveness of the country, and includes impact indicators, including the achievement of at least 2.2% of the total expenditure on research and development (R&D) compared to gross domestic product (GDP) in 2030 (LT: 0.9% in 2017, EU average: 2.06% in 2017).

3.4.4. Other national initiatives

In the area of RES: State and municipal institutions, organisations, and enterprises are obliged, within their competence, to prepare, submit and make public information on the procedure for issuing permits, licenses or certificates, the procedure for examining certification applications, the assistance provided to applicants and support schemes. The ministries are obliged, within their remit, to develop and implement appropriate public information and awareness-raising measures, to provide advice and to develop educational programmes on the practical possibilities and benefits of the development and use of RES.

Exchanges of experience on the use of RES between public authorities, bodies, enterprises, organisations and private entities are organised and examples of good practice are made public.

General programmes in formal education shall include knowledge and skills in the field of RES applications, benefits and technological solutions. Research, public education, training of civil servants and professional training in the field of RES are promoted. The use of pilot projects is encouraged.

Curricula on the benefits and practical possibilities of RES are included in the curricula of Lithuanian schools of general education and in the curricula of Lithuanian university and non-university higher education institutions.

In the national energy portal for consumers, the National Energy Regulatory Council (NERT) publishes information on energy prices from different suppliers, information on energy saving opportunities, etc.

Agreements with energy suppliers on consumer education and consultation on energy consumption issues (energy suppliers will ensure the implementation of the scope of consumer education and consultation and the measures provided for in the agreements between them or through other persons).

It should be noted that all initiatives are aimed at end-users. There are no quality initiatives at national level for workers in the construction and energy efficiency sectors (e.g. designers, builders, contractors, real estate developers). There are individual initiatives, for example, the Lithuania Green Building Council (LGBC)[26] organises training and thematic seminars for green building professionals.

The following consumer information initiatives are planned in the NCEP:

- EN9[27]. Energy poverty and efficiency consultations are included in the catalogue of social services;
- EN10. Obligations of energy suppliers on the prevention of energy poverty;
- EN11. Update of the national energy portal for consumers.

3.4.5. Science, technology and innovation policy

The Ministry of Education, Science and Sport is responsible for shaping the country's education and science policy. The National Programme for the Development of Studies, Scientific Research and Experimental (Social and Cultural) Development for 2013–2020[28] approved by the Government aims to foster sustainable human and social development that strengthens the country's competitiveness and creates conditions for innovation through the development of studies and RDI. The programme does not single out buildings or the energy sector.

The Ministry of Economy and Innovation is responsible for shaping technology and innovation policy. Innovation objectives in different areas of economy (energy systems, industry, transport, agriculture) are included in the general framework of innovation policy. At present, the Lithuanian innovation policy is implemented in the framework of the Lithuanian progress strategy 'Lithuania 2030' under which the National Progress Programme 2014–2020, and the National Progress Plan 2021–2030 are implemented. In addition, different aspects of innovation policy are covered by the Lithuanian Innovation Development Programme 2014–2020. This programme aims to establish a legal framework for strengthening the innovative potential of the business sector, as well as to develop more effective policies and an innovative public sector, and to promote joint activities between business, science and education institutions. One of the measures set out in the programme's implementation plan is aimed at supporting environmentally friendly, energy efficient and green RDI activities that produce and market high value-added products. In addition, areas related to energy and a sustainable environment are also supported through pre-commercial procurement aimed at developing innovative products in this area.

The NECP provides the Alternative horizontal measure of the climate change management policy H8[29]: Promoting research on climate change mitigation and adaptation in 2021–2030; responsible authorities: the Ministry of Education, Science and Sport, the Ministry of Economy and Innovation, the Research Council of Lithuania, and the Ministry of the Environment.

The Government Strategic Analysis Centre (STRATA) performs an annual survey of the Lithuanian innovation ecosystem[30]. The survey does not distinguish the building sector; however, the general country-specific observations are likely to also apply to the building sector. Unless another source is cited, the main conclusions of the review are summarised below.

In 2018, Lithuania's total R&D expenditure amounted to 0.88% of GDP (EUR 396.8 million), of which 0.55% of GDP was spent in the higher education and the general government sectors, and 0.33% of GDP – in the business sector. The trend of the last five years shows that Lithuania has reached the strategic target of 1.9% in 2020. R&D spending will not reach GDP levels.

Lithuania ranks first in the EU in terms of the share of the population aged 30–34 having completed tertiary education (57.6% in 2018, compared to the EU average of 40.7% in 2018). The share of graduates who graduated from natural, technological, medical and health sciences and agricultural sciences accounted for 30 per cent of all graduates in 2017. In 2018, Lithuania's lifelong learning rate (6.6%) was similar to Latvia's (6.7%), and 4.5 percentage points below the EU average.

[26] https://www.lzpt.lt/about-us/
[27] Measure code used by NCEP
[28] https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.439448
[29] The measure code used in the NCEP
[30] https://strata.gov.lt/images/tyrimai/2020-metai/inovaciju-politika/2020-03-13_Inovaciju_apzvalga.pdf

According to the data of the Ministry of Education, Science and Sport[31], the share of students of vocational training institutions in engineering and engineering trades was 24.7% in 2018 (22.7% in 2015), the share of architecture and construction accounted for 11.5% in 2018 (10.9% in 2015). The share of college students in the engineering and engineering trades was 14.4% in 2018, while the share of architecture and construction students was 5.4%. At the start of the academic year 2018, the share of university undergraduate students in engineering and engineering trades was 12.0%, and the share of architecture and construction students was 4.0%. At the start of the academic year 2018, the share of university postgraduate students in engineering and engineering trades was 10.4%, and the share of architecture and construction students was 3.8%.

According to the data of the State Patent Bureau, in 2012–2018, the number of national applications for the subject-matter of industrial property (trademarks, patents, designs) increased by 20% and amounted to 2 930 applications in 2018. In 2018, 81 national patent applications were filed by Lithuanian applicants (of which 30 were filed by science and research institutions, and 51 were filed by businesses). The number of patent applications filed shows the number of inventions and is not related to the commercialisation of the technology and therefore reflects only part of the results of innovative activities.

Ranking of Lithuania in Horizon 2020: as of October 2019, the Lithuanian authorities implemented 340 projects, 69 of which were coordinated by them. Although the quality of Lithuanian applicants' applications is high, and the success rate (13.82% of eligible applications submitted) is above the EU average, we are more than 2.5 times behind Latvia, and more than 6.5 times behind Estonia in terms of applications per capita. In terms of the number of projects, the following technology universities/institutions are in the top five: Kaunas University of Technology, the Lithuanian Energy Institute, and the Research Council of Lithuania[32].

The most significant public sector innovations or initiatives driving innovation in 2019 have been selected (only those related to technologies directly or indirectly linked to the buildings sector):

- The Lithuanian Artificial Intelligence Strategy[33] was launched in April 2019. Lithuania is one of the first EU Member States to present its strategy. Its aim is to create a legal and ethical basis for the application of artificial intelligence in Lithuania, to create preconditions for the development of business and science, and to apply artificial intelligence solutions to the maximum extent of its economic potential. In the energy sector, artificial intelligence systems should be used to develop more efficient ways of supplying energy. Using a more efficient way of distributing energy, Lithuania could increase its sustainability and become less dependent on foreign energy sources.
- To facilitate and promote the development of energy innovations, on 28 April 2020, a law amending the Law No IX-884 of the Republic of Lithuania on Energy was adopted to amend Articles 2, 3, 8, 13-1, 19, 27, and to supplement the Law with Article 18-1, which creates a pilot regulatory environment to test the development of energy innovation.
- The initiative of the Ministry of Energy and the energy company Ignitis, AB to develop solar energy, the online platform Solar Parks (*Saulės parkai*) was launched by Ignitis, which provides the opportunity to purchase or rent a part of the remote solar power plant.
- In 2018, Vilnius Municipality connected part of the buildings owned by it to the Vilnius' PropTech sandbox RealBox established in Vilnius for real estate technology companies, where they can test their innovative solutions.
- The Research and Technology Organisation (RTO) was established to develop the high value-added industry sector by mobilising the potential of the strongest Lithuanian research centres: the Centre for Physical Sciences and Technology, the Lithuanian Energy Institute, the Lithuanian Research Centre for Agriculture and Forestry, and the Science and Technology Park of Institute of Physics.

Implementation of smart technologies in buildings

[31] http://www.nmva.smm.lt/wp-content/uploads/2019/10/Svietimo-bukles-apzvalga-2019-web.pdf
[32] https://webgate.ec.europa.eu/dashboard/sense/app/a976d168-2023-41d8-acec-e77640154726/sheet/0c8af38b-b73c-4da2-ba41-73ea34ab7ac4/state/0
[33] http://kurklt.lt/wp-content/uploads/2019/04/DI_strategija_LT_koreguota.pdf

Heating sector:

- according to the data of the Lithuanian District Heating Association, 14% of the DH consumers in multi-apartment buildings have the possibility to regulate the indoor temperature in their apartment. Each year, the number of such multi-apartment buildings with individual heat meters in the apartments or installed heat distribution devices (allocators) on the radiators increases: There were 1 243 such houses in 2014, 1 979 in 2016, 2 312 in 2017, and 2 586 in 2018. In 2018, 29 343 metering devices were installed in all heat entry points of all buildings, of which almost 55% are equipped with remote data reading systems, and in major cities, such as Kaunas (97%) and Vilnius (89%), the data of metering devices is read remotely[34].

Electricity and natural gas sector:

- implementation of smart meters. ESO power distribution operator plans to install smart electricity meters for its customers, who consume about 90% of the electricity distributed, by the end of 2023. Smart meters will be deployed in phases, starting with the most electricity-consuming customers, followed by other customers. Based on the cost-benefit analysis performed, smart meters will not be installed for natural gas customers yet. More information on the ESO smart meters project can be found at: https://ismaniejiskaitikliai.lt/

Investment in physical infrastructure should be adequately complemented by investment in human capital and the R&D base. For example, the OECD study has shown that a country or region can only generate growth through a cross-cutting approach, i.e. the channelling of public intervention into physical infrastructure alone will not be successful without at the same time stimulating endogenous growth factors such as human capital and innovation.

3.5. ESSENTIAL OBSERVATIONS OF THE CHAPTER

- ✓ The main policy measures currently in place targeting major building renovation target several specific segments of the building sector (multi-apartment and public buildings), with buildings with the lowest energy performance being given separate priority.
- ✓ Measures related to other market failures are applied in the context of existing measures, e.g. information on the benefits of renovation, collection of data on the building stock, etc.

[34] https://lsta.lt/wp-content/uploads/2019/10/LSTA_apzvalga_2018.pdf

4. RENOVATION BARRIERS

Renovation barriers in the context of the LTRS shall be understood as the current obstacles to the implementation of renovation (existing barriers) and the potential risks that may arise because of a significant increase in renovation volumes or newly planned renovation measures (expected barriers).

The identification of the renovation barriers was carried out based on the following essential components of effective renovation:

- **Integrated planning**: The targets set in the LTRS must be properly integrated into both the strategy papers at national level (vertical integration upwards) and the strategic and operational papers of the authorities responsible for implementing the LTRS (vertical integration downwards) and the sectors concerned (horizontal integration).
- **Appropriate package of support measures**: A package of support measures that meets the LTRS indicators and is consumer orientated.
- **Adequate financing**: Even if the benefits of the renovation are believed, significant initial investments are needed, so the building owner will not participate in the renovation if they do not have the financial means for that. Accordingly, there must be attractive financing solutions for the entire necessary financial flow of the owner during the renovation period.
- **Reliable implementation system**: A building owner who believes in the benefits of a renovation may choose not to participate in the renovation if they do not believe that the benefits will be realized, i.e. they will see the barriers at the planning and/or implementation stage, for example:
- **Effective communication**: for a building owner to participate in renovation, he must believe in the benefits of renovation, i.e. know about the benefits of renovation, believe that they are greater than the owner's investment. The owner’s investment is financial, while the benefits of renovation are multifaceted (not only energy savings and reduced costs, but also increase in housing value, improved social environment, improved health, building security, etc.). Accordingly, for a building owner to believe in the benefits of renovation, he must be made aware of the full range of opportunities and benefits of renovation.

An overview of the main barriers to renovation is given below.

4.1.1. Planning stage barriers

B1. Insufficient interinstitutional coordination

Currently, the Ministry of Energy and the Ministry of the Environment are directly responsible for the development and implementation of energy efficiency improvement and RES promotion policy measures at the national level.

Wider complex renovation cases have been implemented (e.g. in Ignalina) which illustrate that renovation may have a significant impact on the heat sector, especially in regions with a small number of new consumers. The impact of renovation is manifested by a significant decrease in heat consumption, where fixed heat production costs remain at the same level and result in a rising heat price for consumers.

The LTRS provides for significantly higher renovation rates than hitherto, therefore the coordination of investments in the heat sector with investments in renovation becomes even more relevant. In addition, the targets set by the LTRS can be achieved only after the transformation of the energy sectors has been implemented (see details in 4.1).

In our assessment, the lack of interinstitutional coordination and the non-integration of the LTRS indicators into the legislative framework may constitute a significant barrier to the implementation of the LTRS.

Proposed measure	P1. Coordinated interinstitutional planning P3. Integration of the renovation indicators into the legislative framework
Priority	High
Implementation perspective	Short-term period

B2. Unreliable (asymmetric) information

Currently, there is no single data source for information on the characteristics, technical condition and actual energy consumption of buildings. In our assessment, the lack of objective and reliable baseline data:

- complicates the planning of the LTRS, the establishment of indicators and the monitoring of their implementation, since both the establishment of indicators and their monitoring must be based on assumptions;
- may become one of the essential barriers to the development of an appropriate package of support measures that meets consumers' expectations;
- this may lead to a situation where different parties involved in the renovation process, such as building owners, policy makers, financial institutions and the like, will have mixed, contradictory or incorrect information about the benefits and opportunities of the renovation.

Unjustified targets increase the risk of missing targets. Unreliable information and inconsistent communication lead consumers to question the benefits of renovation, and financiers to question the viability of renovation projects, etc. Accordingly, data gaps may become a significant, systemic barrier to implementing the indicators of the LTRS.

Proposed measures	P2. Inventory of the building stock and creation of a database P4. Involving local self-government
Priority	High
Implementation perspective	Short-term period

B3. Insufficient involvement of local self-government

Different segments of the building stock have different needs, requiring different renovation measures to realise those benefits. For these needs to be systematically heard and implemented, a more active involvement of the local self-government level is required (i.e. the management level closest to the consumer, which knows the consumer best).

Moreover, the current situation illustrates that it is the self-management abilities and motivation that are critical factors for the success of the renovation or, conversely, the barriers (e.g. In the city of Ignalina, for example, all apartment buildings were renovated, and in Pagėgiai Municipality, no apartment building was renovated[35]).

Accordingly, we believe that the existing *status quo* of the role of local self-government is not sufficient to realize the renovation breakthrough.

Proposed measure	P4. Involving local self-government
Priority	High
Implementation perspective	Short-term period

4.1.2. Barriers to developing support measures

B4. Unattractive payback period for projects

In shaping the package of measures, it is important to consider that low energy prices (see B5), rising construction prices (see B6), energy efficiency measures implemented by the entities with their own capacities (e.g. replaced windows, doors, etc.) and other factors, the payback time of renovation projects increases, exceeds 10–15 years and without state support becomes unattractive neither to the owner of the building nor to the financier (e.g. commercial banks).

Doubts about the recoverability of the project are one of the essential barriers from the perspective of the owner/user of the buildings, which must be addressed through integrated measures. Only financial instruments (subsidisation) require a significant contribution from public finances.

[35] Lithuania's renovation map data by BETA

Proposed measures	P6. Full price of energy P7. Pollution taxes P15. Ensuring funding P17. Communication on the benefits and measures of renovation
Priority	High
Implementation perspective	Medium-term period

B5. Partial price of energy

Low energy prices are a value and one of the measures to reduce energy poverty, increase the competitiveness of enterprises, etc. However, to achieve the indicators, set out in the LTRS, it is important to ensure that, in the long term, energy pricing reflects full energy costs, volumes, both energy production costs (currently the infrastructure of the energy sector is significantly subsidised), as well as environmental and social costs, such as pollution, greenhouse gas emissions, depletion of resources, etc. Otherwise, unsustainably cheap energy acts as a social, energy poverty alleviation measure for a specific segment of consumers but does not promote rational energy consumption or the introduction of energy efficiency measures for the rest of consumers.

In parallel, it is important to emphasise all the benefits of renovation (not only financial) when developing the support package and the communication strategy.

Proposed measures	P6. Full price of energy P7. Pollution taxes
Priority	High
Implementation perspective	Medium-term period

B6. Renovation becoming more expensive

Rising construction prices have an impact on the planning and implementation of energy efficiency projects, as they make investments more expensive and thus increase the payback period of projects. According to the data of the Department of Statistics, the building repair price index grew steadily in the period 2010–2019 (on average 4% annually). Given the current macroeconomic climate and inflation in Lithuania, this trend is likely to continue. In addition, labour shortages remain unmanaged (see B19) may further accelerate the increase in the price of construction works, thereby further increasing the negative impact of this barrier on the implementation of the LTRS.

At the stage of the formation of the support package for the reduction of this barrier, it is recommended to provide for complex measures, e.g. the use of economies of scale (e.g. the interconnection of projects at the level of districts, areas, etc.), industrialisation of renovation (transferring part of the construction work stages from the construction site to the standardised production), and promotion of innovative construction technologies.

Proposed measures	P12. Aggregation of renovation projects P13. Ensuring sustainability and innovation P15. Ensuring funding P18. Implementation of the one-stop shop
Priority	High
Implementation perspective	Medium-term period

B7. Full potential of renovation benefits not realised

The benefits of properly implemented renovation are multifaceted (not only reduced energy costs, but also increase in housing value; upgraded not only building but also urban engineering infrastructure, improved social environment, improved health, etc.). At the same time, different segments of the building stock have different needs, requiring different measures to realise those benefits. For example, the possibility of applying renovation measures flexibly to adapt to the technical condition of a building is particularly relevant to owners of individual houses. Complex, large-scale renovation solutions, which fundamentally change the face of the block and improve the quality of life, are becoming increasingly relevant to multi-apartment buildings[36]. It is also important to note that some segments of the building stock (in buildings with more than one owner) find it difficult to effectively implement renovation measures step by step.

Therefore, to achieve the renovation breakthrough envisaged by the LTRS, it is important to emphasise the following when developing support measures:

- different consumer needs;
- the aim to maximise the benefits of renovation (to the extent that it is rational to promote complex and essential renovation);
- striving to implement renovation measures as concentrated as possible (in stages only if rational, without sacrificing a long-term perspective in the name of short-term effect);
- the reduction of administrative barriers, in particular through the implementation of integrated renovation measures, such as block renovation, where renovation support measures should be further coordinated with site management and development measures.

Proposed measures	P8. Deep renovation P9. Rational renovation P10. District renovation P11. Partial renovation P12. Aggregation of renovation projects
Priority	High
Implementation perspective	Medium-term period

B8. Sustainability of the transformation is not ensured

Europe’s Green Deal commits to not only efficient but also sustainable renovation (see Chapter 5.1). Sustainable renovation is understood as a transformation in line with the fundamental principles of the circular economy, which promotes the reduction of the use of resources necessary for renovation, their reuse and recycling.

To achieve a sustainable transformation of the building stock, it is appropriate to introduce specific solutions promoting the implementation of sustainable renovation when developing support measures. In addition, a period of adaptation to the new requirements is likely to be necessary for both the construction and the design market participants.

Proposed measures	P13. Ensuring sustainability and innovation
Priority	High
Implementation perspective	Medium-term period

4.1.3. Barriers to securing finance

B9. Reluctance of building owners to borrow

For part of the building owners (especially in the residential segment), the need to borrow is one of the essential barriers reducing the willingness to participate in the renovation. The reluctance of residents to borrow was one of the main reasons why no breakthrough in the renovation of multi-apartment buildings occurred after the creation of JESSICA KF in 2009 and access to preferential borrowing facilities[37].

[36] According to the survey conducted by the Association of Lithuanian Housing Chamber, for 93% of the population, the living environment is important.

[37] Ex-ante report data

The reluctance to borrow, even on objectively favourable terms, is influenced both by subjective (e.g. fear, lack of financial understanding, etc.) and objective factors (e.g. unattractive project payback period, uncertainty about interest rates). Accordingly, integrated measures must be taken to remove this barrier:

- elimination of subjective factors: consistent communication emphasising that borrowing for renovation is a financially rational solution as compared to borrowing for an investment in real estate;
- elimination of objective factors: measures reducing the payback period of renovation projects (see barrier B3), measures granting freedom (possibility of early repayment, preferential interest, deferral of loan repayment, etc.).

This barrier can also be addressed by implementing renovation at the initiative of municipalities and transferring administrative and financial obligations to the appointed project administrator.

Proposed measures	P15. Ensuring funding P17. Communication on the benefits and measures of renovation
Priority	High
Implementation perspective	Medium-term period

B10. Inability of building owners to borrow (limited borrowing possibilities)

Even if there is a willingness to borrow, part of the owners of the buildings do not have such an opportunity due to the lack of creditworthiness, which is the main criterion for the decision of the financier to finance the project or not.

In the residential segment, the typical example of insufficient creditworthiness is residents' debts for utilities. If 10% of the population has high debts for utilities and other services, the decision to provide funding may be negative. Borrowing limits are set in the legal framework of public building owners – municipalities, therefore, the possibilities to apply for a loan depend very much on the exhausted borrowing limits. Municipalities whose borrowing limits have been exhausted are in a weak financial situation and commercial banks do not lend.

Proposed measures	P15. Ensuring funding
Priority	Medium
Implementation perspective	Medium-term period

B11. Increased need for public finances

The renovation breakthrough planned by the LTRS significantly increases the need for public contribution, in particular from 2030 onwards (see Chapter 5.2). While the European Green Deal communication declares an initiative to set up centralised, EU-level funding mechanisms, no such decisions have been taken at this stage.

Proposed measures	P15. Ensuring funding
Priority	High
Implementation perspective	Medium-term period

B12. Reluctance of financial institutions to lend (limited lending possibilities)

Parallel to the increased need for financing by the State, the renovation breakthrough planned by the LTRS also constitutes an increase in the financing need for the part of the building owner's contribution. The VIPA study[38] reveals that individual building renovation projects are too small for both international financial institutions, real estate funds and major construction companies, such as:

[38] Assessment of the need for stimulative financing of energy efficiency for economic operators and development of renewable energy sources, VIPA

- European Bank for Reconstruction and Development. One project shall not receive more than 35% of the total project costs; the amount of funding shall not be less than EUR 5 million;
- European Investment Bank. No more than 50% of the total project costs are allocated to one project; the amount of funding is at least EUR 25 million; if the project is smaller, funding may be provided through financial intermediaries;
- Nordic Investment Bank. One project shall not receive more than 50% of the total project costs; the amount of funding shall not be less than EUR 5 million; In view of this, it is likely that no international financial institution would finance individual energy efficiency projects for buildings due to their insufficient size.

Proposed measures	P12. Aggregation of renovation projects
Priority	High
Implementation perspective	Medium-term period

4.1.4. Communications barriers

B13. Insufficient information on the benefits of renovation

The owner’s investment is financial, while the benefits of renovation are multifaceted (not only energy cos savings, but also increase in housing value, improved social environment, improved health, building security, etc.). Accordingly, for a building owner to believe in the benefits of renovation, he must be made aware of the full range of opportunities and benefits of renovation. This is particularly the case where, due to the inclusion of incomplete costs, the price of energy is low (see B5) and, as a result, the financial benefits of renovation do not constitute a sufficient motivation to participate in renovation.

Proposed measures	P17. Communication on the benefits and measures of renovation
Priority	High
Implementation perspective	Medium-term period

B14. Insufficient information on the inevitability of renovation

One of the essential barriers to the rapid implementation of renovation is the lack of communication on the inevitability of renovation, i.e. the emphasis on the absence of a choice to participate in renovation in the long term for the part of the low energy efficiency building stock. The essential factors that make renovation inevitable:

- the poor technical condition of most buildings (by 2050, some of them will have to be renovated anyway, with or without public support);
- Lithuania, as an EU country, must comply with the provisions of EU strategic documents (regulations, the Green Deal, etc.). fulfilling EU obligations is part of being in the EU;
- accordingly, disciplinary measures (pollution taxes, restrictions on the rent/sale of inefficient buildings, etc.) intended to manage irresponsible and irrational behaviour of building owners will inevitably appear alongside incentives to participate in renovation.

Communication on the inevitability of renovation should focus on two segments:

- building owners (motivating them to participate);
- representatives of construction, design, financing and other stakeholders involved in renovation (providing assurance that public policy on this issue is clear, binding and long-term).

Proposed measures	P16. Communicating the inevitability of renovation
Priority	High
Implementation perspective	Medium-term period

4.1.5. Barriers to implementation

B15. Insufficient managerial capacity of municipalities

To achieve a renovation breakthrough and delegate more functions to municipalities, it must be borne in mind that insufficient municipal management capacities may become a critical barrier in the LTRS implementation process. Different results of municipalities in the implementation of the multi-apartment renovation programme (see B3) shows that the management capacity of municipalities is not even and is likely to be generally insufficient in some municipalities.

Proposed measures	P19. Establishment of a competence centre
Priority	High
Implementation perspective	Medium-term period

B16. Barriers to the procurement process

Currently, construction works may be purchased either through the e-procurement centre owned by the central purchasing body (CPB LT) or in accordance with the procedure approved by the order of the Minister for the Environment. Meanwhile, other services necessary for the renovation of multi-apartment buildings are provided only through the CPB LT.

Although the standardisation of the procurement process implemented through the EPC significantly facilitates the procurement process from the administrative point of view (no need to prepare procurement documents, no need to carry out the selection of the winner, formation of the contract, etc.), standardisation also has its negative side – it eliminates the possibility to realize part of the buyer's needs, e.g. to place more emphasis on quality than price (no possibility to apply the principle of cost-effectiveness), to establish additional criteria to ensure that the purchased services will be performed in a timely and qualitative manner (e.g. to require the tenderers to provide a list of completed projects and recommendations of former clients).

To achieve the paces of renovation envisaged in the LTRS, standardisation of the procurement process is a strategically correct direction and one of the success factors, but the same standardisation can become a barrier if it does not meet the needs of a significant part of consumers.

Proposed measures	P19. Establishment of a competence centre
Priority	High
Implementation perspective	Medium-term period

B17. Poor quality investment plans

Currently, for the owners of buildings to receive state support for renovation, the project administrator must submit to the Agency together with the application the investment plan for the modernisation of the multi-apartment building prepared and approved by most of the owners of the apartments and other premises of the multi-apartment building. The project administrator is responsible for the organisation of the procurement of services for the preparation of the modernization investment plan, which must also assess the compliance of the prepared investment plan with the technical task for its preparation.

The results of the audit carried out by the National Audit Office of Lithuania[39] show that in 2014–2018 BETA due to deficiencies in the preparation of investment plans, 78% of the applications were returned for adjustment. Around 29.3% of the applications were rejected without rectifying the discrepancies and clarifying them. In addition, 9% of the investment plans, due to the discrepancies identified therein, were revised during the modernisation of the multi-apartment building. The adjustment had an impact on the fact that 31% of the projects had a delay of more than 18 months. In the event of prolonged implementation, the residents of these houses are inconvenienced by the presence of debris, dust and noise on the construction site for a long time.

[39] Public Audit Report on the Renovation (Modernisation) of Multi-apartment Buildings, the National Audit Office of Lithuania

The need to adjust more than ¾ of the investment plans indicates that the barrier is systemic. Given that negative examples tend to spread faster and to a greater extent than positive ones and have a greater impact on the target audience than official communication, such a situation may become a major barrier to building owners' decision to participate in the modernisation process.

Proposed measures	P19. Establishment of a competence centre P20. Ensuring maintenance
Priority	High
Implementation perspective	Medium-term period

B18. Insufficient quality control of renovation implementation

The results of the audit carried out by the National Audit Office reveal that administrators of projects for the modernisation of multi-apartment buildings, representing the owners of apartments and other premises of multi-apartment buildings, often perform the duties of a builder (client) inappropriately, i.e. by organising the technical supervision of the work on the multi-apartment building being renovated, they do not ensure that the work is carried out without defects and in accordance with the investment plan for the modernisation of the multi-apartment building.

Maintenance as a separate quality assurance element, process-wise at the end of the process, is not sufficient to remove the barrier. A systematic approach to renovation quality control and the integration of the necessary fuses into the whole process is necessary: training of contractors, tightening of qualification requirements, proper maintenance, publicity of poorly performing construction participants and limitation of their participation in renovation tenders.

Proposed measures	P20. Ensuring maintenance
Priority	High
Implementation perspective	Medium-term period

B19. Restrictions on the workforce in the construction sector

As the pace of renovation increases, insufficient number of builders may become a barrier to quality project implementation. In addition, labour shortages may lead to wage increases in the sector, which in turn may lead to higher construction prices (see B6).

Proposed measures	P1. Coordinated interinstitutional planning P13. Ensuring sustainability and innovation P16. Communicating the inevitability of renovation
Priority	High
Implementation perspective	Medium-term period

B20. Insufficient motivation of public building managers

According to the applicable legal regulation, state institutions (budgetary institutions) and municipal managers of public buildings have no right to freely dispose of the appropriations allocated from the state or municipal budget, therefore, even after saving a certain amount of funds, the fact of saving is not felt. This leads to a lack of motivation to save energy due to a lack of direct sight of savings. The procedure for allocating the budget and transferring funds is discussed under the regulatory constraints below.

Proposed measures	P8–P11. Complex motivational measures (obligations combined with support measures) P15. Ensuring funding
Priority	High
Implementation perspective	Medium-term period

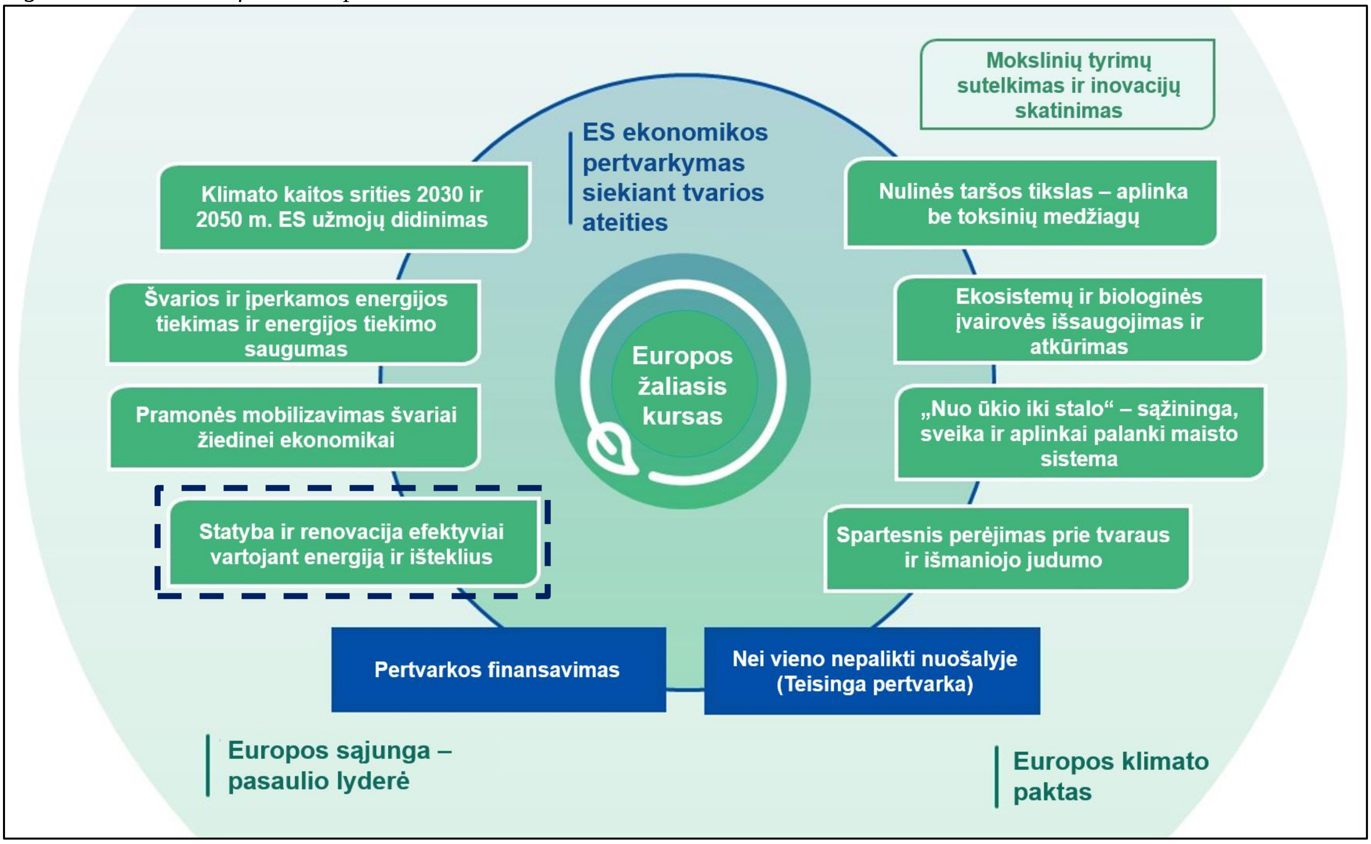
5. OBJECTIVES, INDICATORS AND BENEFITS OF THE RENOVATION STRATEGY

Article 2a(2) of the EPBD provides that 'In its long-term renovation strategy, each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80–95% compared to 1990, to ensure a highly energy efficient and decarbonised national building stock and to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU.'.

The long-term renovation of buildings is one of the cornerstones of the European Green Deal[40]. The European Green Deal is a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use.

[40] https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en#policy-areas

Figure 19. Elements of the European Green Deal



Source: European Commission

The following section provides information on the purpose of the renovation strategy, measures and planned indicators of progress:

- the objective of the strategy (Chapter 5.1);
- indicators for implementing the strategy (Chapter 5.2);
- the wider benefits of implementing the strategy (Chapter 5.3).

5.1. GOAL OF THE STRATEGY

The Strategy aims to transform the existing building stock so that it is energy efficient (complying with the conditions for conversion to near-zero energy buildings), decarbonised, and in line with the principles of universal design by 2050.

To implement this goal, the following indicators are set to be achieved by 2050 (compared to 2020):

- to reduce the annual primary energy consumption of the building stock to 16.2 TWh (60%);
- to reduce the annual consumption of primary energy from fossil fuels in the building stock to 0 TWh (100%);
- to reduce the annual CO_2 emissions of the building stock to 0 mtCO_2 (100%).

It is important to note that the building stock, as an energy consumer, is an integral part of the energy sector. The transformation indicators of the building stock described above have been established assuming that the energy sector will transform in parallel to respond to changing consumer needs.

The figure below illustrates the dependence of the transformation of the building stock on the transformation of the energy sector:

- column ‘2050’ shows the indicator target values that could be achieved only after the transformation of the building stock has been carried out, i.e. after the implementation of renovation measures to increase the energy efficiency of buildings to the specified extent, and the replacement of non-RES individual production sources with RES.
- column ‘2050 +’ shows the indicator target values set by the LTRS which could be achieved through the transformation of both the building stock (energy consumption) and the energy sector (energy production).

Figure 20. Transformation indicators of the building stock

		2020	2050		2050 +	
1	Pirminė energija iš viso	40,8 TWh	-60%	15,8 TWh	-60%	16,2 TWh
2	Pirminė energija iš iškastinio kuro	26,4 TWh	-70%	8,3 TWh	-100%	0 TWh
3	CO_2 emisijos	5,3 $mtCO_2$	-70%	1,5 $mtCO_2$	-100%	0 $mtCO_2$

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

A description of the target values for the indicators is given below.

5.1.1. Reduction of primary energy consumption

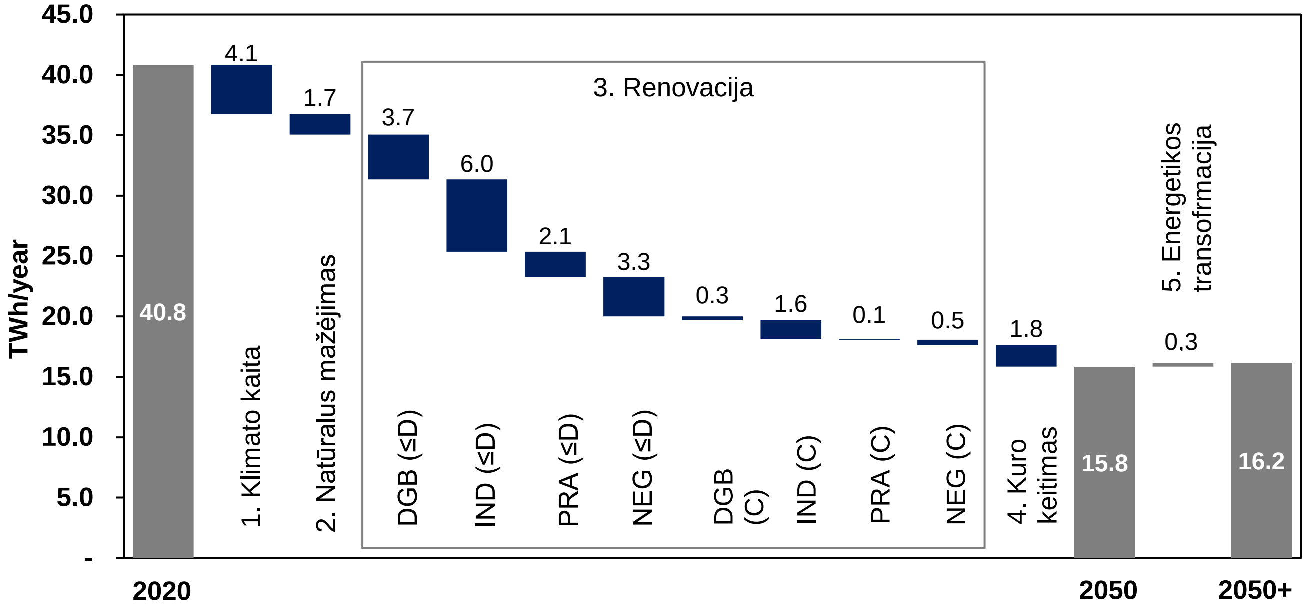
Article 2a(2) of the EPBD obliges Member States to ensure a highly energy efficient and decarbonised national building stock by 2050 to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings.

The results of the primary energy consumption analysis of the building stock show that 90% of the primary energy consumption of the building stock is accounted for by buildings in energy class C and lower (see Chapter 1.2.5).

The results of the assessment of the most cost-effective renovation methods show that the maximum economic benefit at the level of the building stock would be achieved by implementing renovation measures that would transform buildings in energy performance class C and lower into energy performance class A (priority) or B, giving priority to the least efficient buildings (energy performance classes D and lower) consuming 78% of the primary energy of the building stock (see Chapter 2).

The target to reduce the primary energy consumption of the building stock to 16.2 TWh by 2050 (60% of the calculated 2020 consumption) has been formed by assessing and forecasting the changes in the building stock, both due to the transformation measures provided for in the LTRS and related structural changes, such as climate change, and demographic trends (see the figure below).

Figure 21. Transformation components of the building stock (reduction of primary energy)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The target to reduce the primary energy consumption of the building stock to 16.2 TWh by 2050 (60% of the calculated 2020 consumption) has been formed by forecasting that:

1. the primary energy consumption of the building stock in 2050 will be ~4.1 TWh (10%) lower than in 2020 due to the impact of climate change (see Chapter 1.2.1);
2. demographic trends will result in at least 5% of the buildings of the building stock being abandoned, demolished and/or not used for energy purposes by 2050 (see Chapter 1.4.3);
3. the transformation of the building stock will be carried out:
   - at least 90% of the worst energy performance classes (C and lower) of individual, multi-apartment and other non-residential buildings will participate in the transformation of the building stock.

     This assessment assumes that by 2050, the age of most of these buildings will reach the threshold for mandatory refurbishment to continue their safe use. Based on the principle of conservatism, it is estimated that 10% of the buildings will refuse to participate in the renovation for subjective reasons but will continue to be used.
   - at least 50% of the worst energy performance classes (C and lower) of industrial buildings will participate in the transformation of the building stock.

     This assessment assumes that the motivation of industrial building owners to renovate buildings is exclusively financial (other incentives affecting the owners of other buildings affect less), while energy efficiency often does not contribute to the improvement of business processes and does not bring significant returns (in particular, to the current energy prices). Accordingly, the main planned measure is the increase of the requirements for the reconstruction of buildings (from energy performance class C to B and A). Following the principle of conservatism, it is estimated that by 2050, 50% of industrial buildings will not be renovated, but will continue to be used.
   - 50% of buildings in energy performance classes D and below will achieve energy performance classes A and B, and 100% of buildings in energy performance class C will achieve energy performance class A. The assessment assumes that, depending on the technical characteristics of the building and/or the needs of the building owner, the choice of the EPC to be sought may vary;
   - 100% of buildings whose existing heat energy source is not DH, together with energy efficiency improvement measures, will also install RES measures (heat pumps and photovoltaic solar cells);
4. all buildings not involved in the renovation and using fossil fuels that are not connected to DH will switch production to RES using e.g. heat pumps and photovoltaic solar cells or biofuel boilers. This

assessment is based on the objective of the complete elimination of fossil fuel sources by replacing them with RES;

5. the transformation of the energy sector will take place – the DH and electricity sectors will produce 100% of their energy from RES. Various innovations and strict regulation of the energy sector will allow to contain 100% of the waste. CO_2 emissions from energy production processes in both electricity and heat plants and heat sources in individual homes. This assessment assumes that the objectives declared in the NEIS, and other strategic legislation will be achieved.

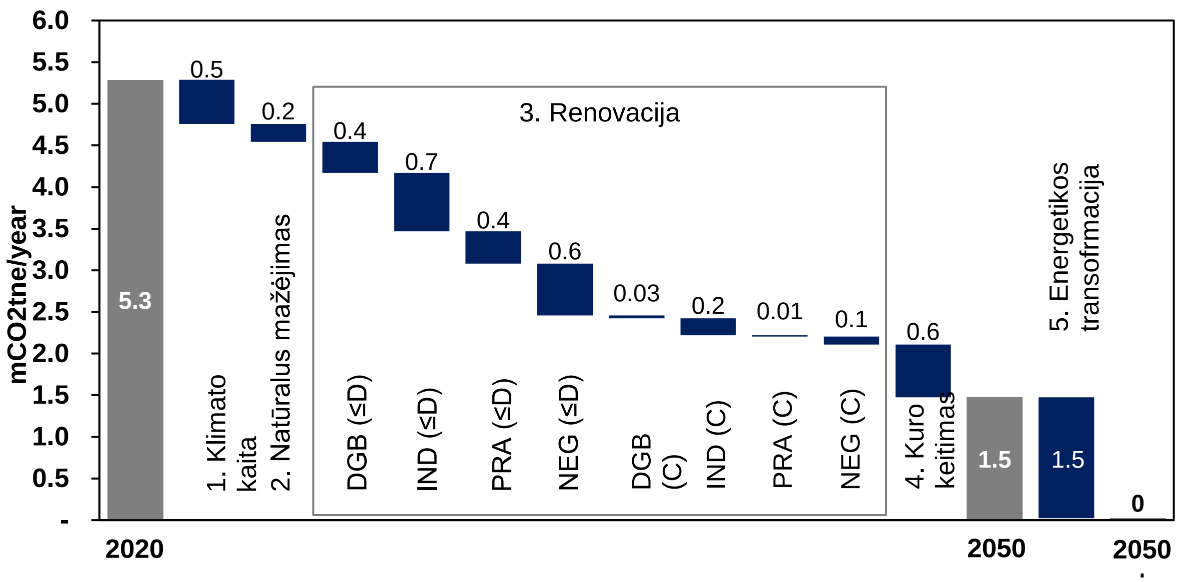
It is important to note that the energy consumption to be calculated in 2020 is based on assumptions (see Chapters 1.2 and 1.3) due to data gaps, and therefore the actual data on the energy consumption of the building stock may change. Accordingly, more attention should be paid not to the ratio (save 70%), but to the absolute consumption (16.2 TWh), i.e. to transform the building stock used into EPC A and B.

5.1.2. Elimination of primary energy from fossil fuels

The goal to eliminate 100% of primary energy from non-RES and to achieve zero CO_2 emissions (column '2050+' in the figure above) is based on the projection that by 2050:

- energy efficiency measures will be implemented (see Chapter 5.1.1);
- the electricity sector will transform 100% into a zero CO_2 emission sector;
- the DH sector will transform 100% into a zero CO_2 emission sector;
- all buildings in the building stock (2020) not connected to DH will use individual RES production sources.

Figure 22. Transformation components of the building stock (reduction of CO2 emissions)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

It is important to note that the achievement of these indicators requires not only the implementation of renovation measures, but also the impact of wider external factors, such as:

- the RES technology evolution. Currently, a significant part of RES measures is not CO_2 neutral, therefore, even if all building production sources were changed to not using fossil fuels, CO_2 emissions would not be zero;
- developments in sustainability-oriented policy instruments. For example, a change in the status of biofuels as a source of RES production would result in a significant share of current RES production sources becoming non-RES, etc.

5.2. INDICATORS FOR IMPLEMENTING THE STRATEGY

The table below sets out the preliminary indicators for the implementation of the LTRS for 2030, 2040, and 2050.

Table 51. Indicators targeted by the renovation strategy

Indicator	Unit of measure	2020	2030	2040	2050
R1. Primary energy consumption per year	GWh	40 827	34 759	25 888	16 162
R2. Primary energy consumption per year (compared to 2020)	(%)	100%	85%	63%	40%
R3. Primary energy (non-RES) consumption per year	GWh	26 407	19 865	10 369	27
R4. Primary energy (non-RES) consumption per year (compared to 2020)	(%)	100%	75%	39%	0%
R5. CO2 emissions	ktCO2	5 287	4 003	2 108	0
R6. CO2 emissions (compared to 2020)	(%)	100%	76%	40%	0%
R7. Area of inefficient buildings (class D and lower)	thousand m^2	108 924	85 887	54 043	19 981
R8. Area of inefficient buildings (class D and lower)	GWh	31 601	24 208	14 306	3 717
R9. Consumption by inefficient buildings (class D and lower) (compared to 2020)	(%)	100%	77%	45%	12%
R10. Number of renovated buildings	units	58,774*	99 281**	255 421**	436 008**
R11. Share of renovated buildings	(%)	8%*	17%**	43%**	74%**
R12. Area of renovated buildings	thousand m^2	29 471*	27 819**	67 233**	109 534**
R13. Area of renovated buildings	(%)	15%*	17%**	41%**	66%**

Source: The authors of the study to develop the long–term renovation strategy of Lithuania

**New and renovated buildings in energy performance class B and higher by 2020.*
***Buildings to be renovated from 2021 with intermediate indicators for 2030, 2040, and 2050*

To summarise the above data, it can be observed that:

- during the planned period, the aim will be that almost 440 thousand buildings (74% of the total building stock) will be involved in the renovation;
- renovation and transformation of the energy sector will result in a 60% reduction in primary energy consumption (88% for the most inefficient buildings), CO_2 emissions will be reduced by 100%;
- the share of buildings with the lowest energy efficiency in the total stock will decrease from 66% (2020) to 25% (2050).

Obviously, both the pace of renovation (number of buildings renovated) and the depth of renovation (achieved savings from renovation measures) must increase significantly to achieve the IRS transformation indicators. Accordingly, the need for investment and financing will increase significantly.

Renovation paces

To achieve the renovation paces necessary for the transformation of the building stock, a 'run-up' period is needed to develop support packages, make the necessary changes to legislation, and allow the construction and financial sectors to adapt their resources, processes, etc.

The increase in the number of buildings planned to be renovated per year is shown in the table below, which reflects both the run-up period and the priority given to larger buildings (multi-apartment buildings) at the beginning of the LTRS implementation period.

Table 52. Renovation paces: the number of buildings under renovation per year

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	units/year	760	1 086	1 083	934
Private houses	units/year	6 500	8 485	12 702	14 935
Industrial facilities	units/year	308	428	682	816
Other non-residential buildings	units/year	518	719	1 147	1 373
Total	**units/year**	**8 086**	**10 717**	**15 614**	**18 059**

Source: The authors of the study to develop the long–term renovation strategy of Lithuania

Table 53. Renovation paces: the area of buildings renovated per year

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	thousand m^2/year	950	1 265	1 243	1 028

Private houses	thousand m²/year	672	878	1 314	1 545
Industrial facilities	thousand m²/year	212	295	470	563
Other non-residential buildings	thousand m²/year	413	573	914	1 094
Total	thousand m²/year	**2 248**	**3 011**	**3 941**	**4 230**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Renovation investment

The table below provides a summary of the annual investments required to implement the renovation.

Table 54. Investment needs for the renovation implementation per year[41]

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	EUR million/year	286	419	487	492
Private houses	EUR million/year	328	475	844	1 202
Industrial facilities	EUR million/year	88	136	258	374
Other non-residential buildings	EUR million/year	166	255	483	700
Total	**EUR million/year**	**867**	**1 286**	**2 071**	**2 767**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Renovation subsidising

Due to the low energy prices and, consequently, the long payback period, it is expected that the implementation of the renovation will require an incentive through public funds (subsidies). The estimated need (per year) for subsidies to implement the renovation are shown in the table below. The need for subsidies has been calculated based on the funding intensity of the renovation support measures currently in place, where 30% of the investments are financed. In the case of multi-apartment buildings, support for drafting investment projects and project administration was additionally assessed, accounting for an additional 10% of investments.

Table 55. Subsidy needs for the renovation implementation

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	EUR million/year	114	168	195	197
Private houses	EUR million/year	98	143	253	360
Industrial facilities	EUR million/year	27	41	77	112
Other non-residential buildings	EUR million/year	50	77	145	210
Total	**EUR million/year**	**289**	**428**	**670**	**879**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Renovation financing

It is expected that a significant part of building owners wishing to participate in the renovation process will need financing solutions for the part of their own contribution. The maximum annual financing need for the implementation of the renovation, calculated based on the assessment that the credit will be required for the entire share of the building owners' contribution, is shown in the table below.

Table 56. Financing needed to implement the renovation

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Multi-apartment buildings	EUR million/year	171	251	292	295
Private houses	EUR million/year	230	333	591	841
Industrial facilities	EUR million/year	62	95	180	261
Other non-residential buildings	EUR million/year	116	179	338	490
Total	**EUR million/year**	**579**	**858**	**1 401**	**1 888**

[41] The investment calculations cover only the measures applied in buildings, i.e. they do not cover investments for the transformation of the energy sector.

Source: The authors of the study to develop the long–term renovation strategy of Lithuania

Considering the limited capacity of the State to provide funding (from its own resources or from support funds), the ability to create and offer to the market financial measures with a high leverage effect[42] and involving private funds, pension funds and international financial institutions is of great importance for ensuring financing.

5.2.1. Multi-apartment buildings

The table below shows the targets for the renovation of multi-apartment buildings:

Table 57. Renovation indicators of multi-apartment buildings

Indicator	Unit of measure	2020	2030	2040	2050
R1. Primary energy consumption per year	GWh	11 977	9 891	7 676	5 844
R2. Primary energy consumption per year (compared to 2020)	(%)	100%	83%	64%	49%
R3. Primary energy (non-RES) consumption per year	GWh	7 243	4 781	2 165	3
R4. Primary energy (non-RES) consumption per year (compared to 2020)	(%)	100%	66%	30%	0%
R5. CO2 emissions	ktCO2	1 279	846	385	0
R6. CO2 emissions (compared to 2020)	(%)	100%	66%	30%	0%
R7. Area of inefficient buildings (class D and lower)	thousand m^2	34 090	23 937	12 863	3 228
R8. Consumption by inefficient buildings (class D and lower)	GWh	9 548	6 631	3 477	693
R9. Consumption by inefficient buildings (class D and lower) (compared to 2020)	(%)	100%	69%	36%	7%
R10. Number of renovated buildings	units	4 735*	9 881**	20 715**	30 060**
R11. Share of renovated buildings	(%)	12%*	24%**	51%**	74%**
R12. Area of renovated buildings	thousand m^2	9 381*	11 704**	24 137**	34 415**
R13. Area of renovated buildings	(%)	16%*	25%**	51%**	72%**

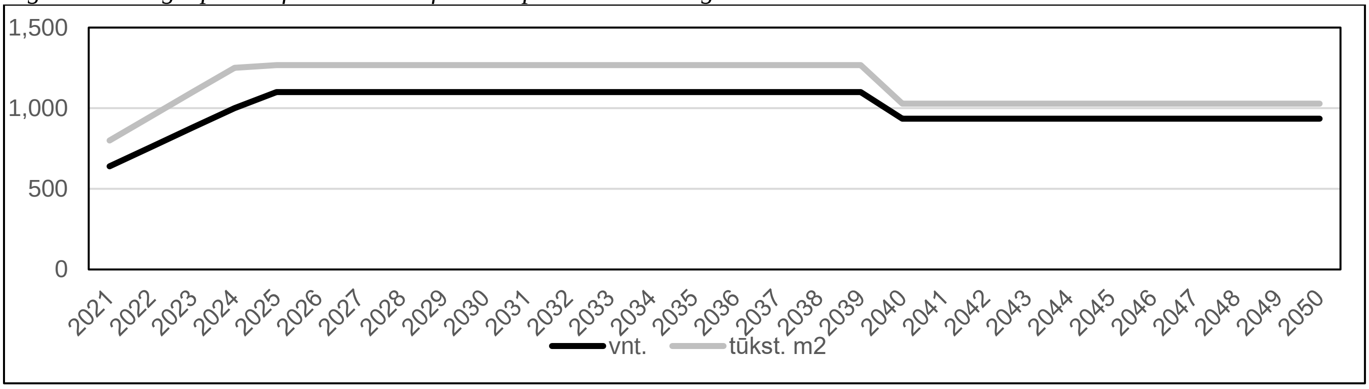
Source: The authors of the study to develop the long-term renovation strategy of Lithuania
**New and renovated buildings in energy performance class B and higher by 2020.*
***Buildings to be renovated from 2021 with intermediate indicators for 2030, 2040, and 2050*

To summarise the above data, it can be observed that:

- the aim is to renovate 30 thousand buildings during the planned period;
- multi-apartment buildings will account for only 7% of the total number of buildings to be renovated, but will achieve as much as 25% savings in primary energy and 24% in reduction of CO_2 emissions;
- renovation and transformation of the energy sector will result in a 51% reduction in primary energy consumption (93% for the most inefficient buildings);
- renovation and transformation of the energy sector will result in a 100% reduction of CO_2 emissions.

[42] Instruments with a 1:5 leverage effect are currently being developed in the renovation of multi-apartment buildings, i.e. aiming to leverage 5 euro from the private sector or other third parties for every euro of public finance.

Figure 23. Target paces of renovation of multi-apartment buildings



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The forecast of the rates of renovation of multi-apartment buildings is based on the planned support measures aimed at the promotion of block renovation (see Chapter 6.2).

5.2.2. Private houses

The table below shows the indicators for the renovation of private houses:

Table 58. Renovation indicators of private houses

Indicator	**Unit of measure**	**2020**	**2030**	**2040**	**2050**
R1. Primary energy consumption per year	GWh	13 819	11 693	8 269	4 244
R2. Primary energy consumption per year (compared to 2020)	(%)	100%	85%	60%	31%
R3. Primary energy (non-RES) consumption per year	GWh	7,581	5,899	3,192	9
R4. Primary energy (non-RES) consumption per year (compared to 2020)	(%)	100%	78%	42%	0%
R5. CO2 emissions	ktCO2	1,570	1,224	666	0
R6. CO2 emissions (compared to 2020)	(%)	100%	78%	42%	1%
R7. Area of inefficient buildings (class D and lower)	thousand m^2	25,937	20,527	12,161	2,424
R8. Consumption by inefficient buildings (class D and lower)	GWh	9,714	7,531	4,330	657
R9. Consumption by inefficient buildings (class D and lower) (compared to 2020)	(%)	100%	78%	45%	7%
R10. Number of renovated buildings	units	47 503*	78 893**	205 913**	355 261**
R11. Share of renovated buildings	(%)	9%*	17%**	44%**	76%**
R12. Area of renovated buildings	thousand m^2	8 124*	8 162**	21 302**	36 752**
R13. Area of renovated buildings	(%)	12%*	16%**	43%**	74%**

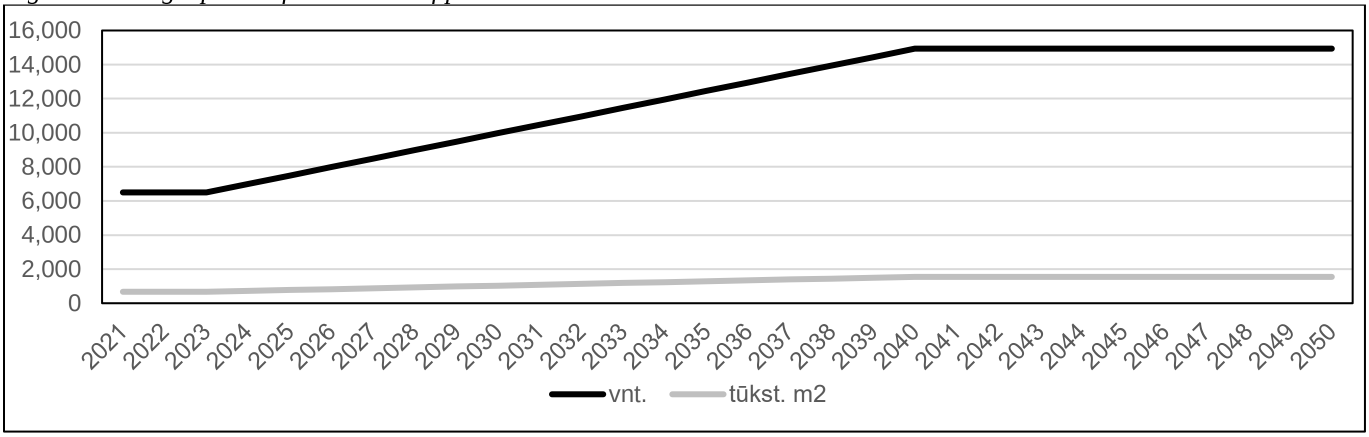
Source: The authors of the study to develop the long-term renovation strategy of Lithuania
**New and renovated buildings in energy performance class B and higher by 2020.*
***Buildings to be renovated from 2021 with intermediate indicators for 2030, 2040, and 2050*

To summarise the above data, it can be observed that:

- the aim is to renovate 355 thousand buildings during the planned period;
- private houses will account to 81% of the total number of buildings to be renovated, achieving 39% savings in primary energy and 30% in reduction of CO_2 emissions;
- renovation and transformation of the energy sector will result in a 69% reduction in primary energy consumption (93% for the most inefficient buildings);
- renovation and transformation of the energy sector will result in a 100% reduction of CO_2 emissions.

To achieve these targets, at least 6 500 individual houses will need to be renovated in 2021–2023, with a subsequent annual increase in the renovation rate of at least 500 buildings, to reach almost 15 000 renovations per year in 2040 and to maintain this rate until 2050.

Figure 24. Target paces of renovation of private houses



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The forecast of the rates of individual house renovation is based on the voluntary renovation by the building owners (see Chapter 1.4.4) and the planned support measures aimed at the promotion of partial renovation.

5.2.3. Other non-residential buildings

The table below shows the targets for the renovation of other non-residential buildings:

Table 59. Renovation indicators for other non-residential buildings

Indicator	Unit of measure	2020	2030	2040	2050
R1. Primary energy consumption per year	GWh	7 765	6 742	4 962	2 831
R2. Primary energy consumption per year (compared to 2020)	(%)	100%	87%	64%	36%
R3. Primary energy (non-RES) consumption per year	GWh	5 962	4 728	2 580	7
R4. Primary energy (non-RES) consumption per year (compared to 2020)	(%)	100%	79%	43%	0%
R5. CO2 emissions	ktCO2	1 258	998	545	3
R6. CO2 emissions (compared to 2020)	(%)	100%	79%	43%	0%
R7. Area of inefficient buildings (class D and lower)	thousand m^2	23 416	18 875	11 263	2 225
R8. Consumption by inefficient buildings (class D and lower)	GWh	5 788	4 556	2 619	355
R9. Consumption by inefficient buildings (class D and lower) (compared to 2020)	(%)	100%	79%	45%	6%
R10. Number of renovated buildings	units	4 404*	6 589**	18 057**	31 787**
R11. Share of renovated buildings	(%)	10%*	16%**	44%**	77%**
R12. Area of renovated buildings	thousand m^2	7 573*	5 251**	14 390**	25 332**
R13. Area of renovated buildings	(%)	20%*	14%**	39%**	69%**

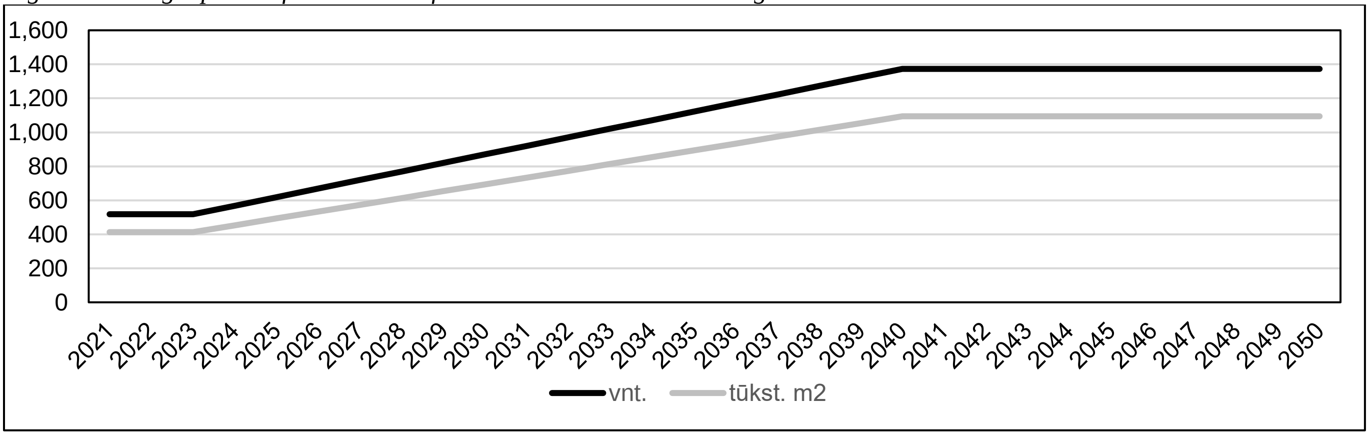
Source: The authors of the study to develop the long-term renovation strategy of Lithuania
**New and renovated buildings in energy performance class B and higher by 2020.*
***Buildings to be renovated from 2021 with intermediate indicators for 2030, 2040, and 2050*

To summarise the above data, it can be observed that:

- the aim is to renovate 32 thousand buildings during the planned period;
- other non-residential buildings will account for only 7% of the total number of buildings to be renovated (23% of the total surface), achieving 20% savings in primary energy, and 24% in reduction of CO_2 emissions;
- renovation and transformation of the energy sector will result in a 64% reduction in primary energy consumption (94% for the most inefficient buildings);
- renovation and transformation of the energy sector will result in a 100% reduction of CO_2 emissions.

To achieve these targets, at least 500 non-residential buildings will need to be renovated in 2021–2023, with a subsequent annual increase in the renovation rate of at least 50 buildings, to reach almost 1 400 buildings under renovation per year in 2040.

Figure 25. Target paces of renovation of other non-residential buildings



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The forecast of the rates of renovation of other non-residential buildings is based on the planned support measures aimed at integrated planning (public buildings) and block renovation (see Chapter 6.2).

5.2.4. Industrial buildings

The table below shows the targets for the renovation of industrial buildings:

Table 60. Renovation indicators of industrial buildings

Indicator	Unit of measure	2020	2030	2040	2050
R1. Primary energy consumption per year	GWh	7 267	6 432	4 981	3 243
R2. Primary energy consumption per year (compared to 2020)	(%)	100%	89%	69%	45%
R3. Primary energy (non-RES) consumption per year	GWh	5 621	4 457	2 432	7
R4. Primary energy (non-RES) consumption per year (compared to 2020)	(%)	100%	79%	43%	0%
R5. CO2 emissions	ktCO2	1 180	936	512	4
R6. CO2 emissions (compared to 2020)	(%)	100%	79%	43%	0%
R7. Area of inefficient buildings (class D and lower)	thousand m^2	25 481	22 547	17 756	12 104
R8. Consumption by inefficient buildings (class D and lower)	GWh	6 552	5 491	3 880	2 013
R9. Consumption by inefficient buildings (class D and lower) (compared to 2020)	(%)	100%	84%	59%	31%
R10. Number of renovated buildings	units	2 132*	3 918**	10 736**	18 901**
R11. Share of renovated buildings	(%)	4%*	9%**	26%**	45%**
R12. Area of renovated buildings	thousand m^2	4 393*	2 702**	7 404**	13 033**
R13. Area of renovated buildings	(%)	12%*	9%**	23%**	41%**

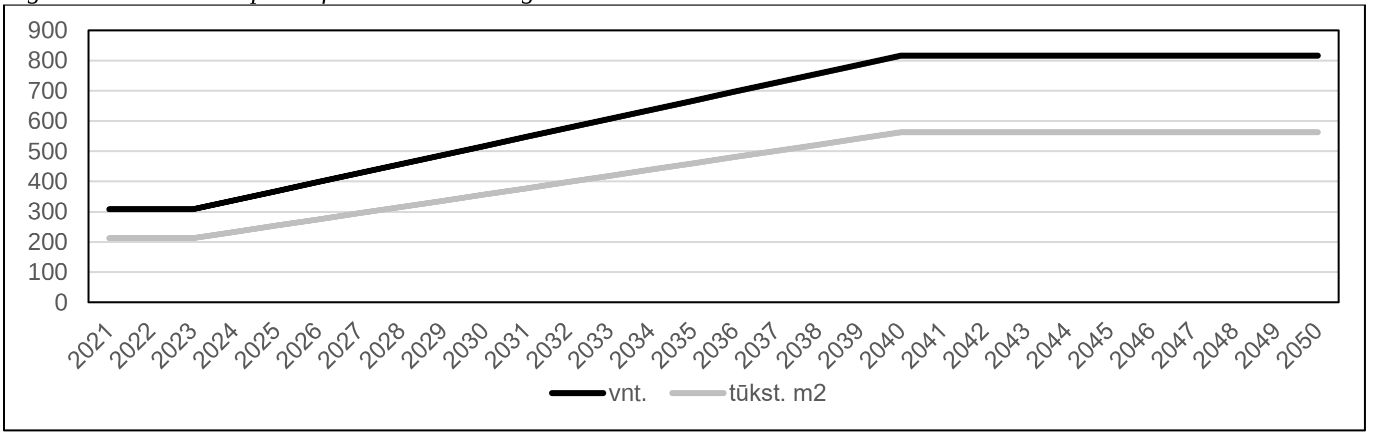
Source: The authors of the study to develop the long-term renovation strategy of Lithuania
**New and renovated buildings in energy performance class B and higher by 2020.*
***Buildings to be renovated from 2021 with intermediate indicators for 2030, 2040, and 2050*

To summarise the above data, it can be observed that:

- the aim is to renovate nearly 19 thousand buildings during the planned period;
- Industrial buildings will account for only 4% of the total number of buildings to be renovated (12% of the total surface), achieving 16% savings in primary energy, and 22% in reduction of CO_2 emissions;
- renovation and transformation of the energy sector will result in a 55% reduction in primary energy consumption (69% for the most inefficient buildings);
- renovation and transformation of the energy sector will result in a 100% reduction of CO_2 emissions.

To achieve these targets, at least 300 industrial buildings will need to be renovated in 2021–2023, with a subsequent annual increase in the renovation rate of at least 30 buildings, to reach over 800 buildings under renovation per year in 2040.

Figure 26. Renovation pace of industrial buildings



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The forecast of the rates of renovation of industrial buildings is based on the planned support measures aimed at the establishment of energy performance requirements for the buildings under reconstruction and block renovation (in the cities) (see Chapter 6.2).

5.3. DIRECT AND WIDER BENEFITS OF IMPLEMENTING THE STRATEGY

Article 2a(1)(g) of the EPBD provides that each LTRS shall encompass 'an evidence-based estimate of expected energy savings and wider benefits, such as those related to health, safety and air quality.'.

While the LTRS's indicators emphasise renovation costs related to energy saving and GHG emission reduction, building renovation also generates other significant benefits, both direct (improvement of technical condition of buildings, restoration) and indirect benefits of wider scale.

Although EPBD does not provide a comprehensive list of the types of wider benefits that should be valued by the LTRS, a summary of the results of the studies that have looked at the benefits of building renovation[43] suggests that all the direct and wider benefits of building renovation can be grouped into the following main categories:

- environmental benefits (e.g. reduced use of resources, reduced air pollution, etc.);
- economic benefits (e.g. GDP growth, increase in the value of buildings, improvement in the technical condition of buildings, increased productivity in individual sectors, etc.);
- social benefits (e.g. reduction of energy poverty, improved quality of life, etc.).

Due to their nature or lack of data, not all benefits of building renovation can be measured reliably in monetary terms (monetised). Accordingly, this chapter provides a description of the benefits of major building renovation, distinguishing between monetisable and non-monetisable benefits.

5.3.1. Monetisable benefits of building renovation

The calculations of the most cost-effective way of renovation, together with the direct benefits of renovation (energy savings and reduced CO_2 emissions), have already assessed the increase in GDP. In addition, the wider benefits of all 3 main groups of benefits which can be most reliably predicted and estimated shall be assessed and calculated.

The table below provides a summary of the estimated direct and wider benefits.

Table 61. Benefits of the LTRS implementation (real value[44])

Indicator	Unit of measure	2021–2030	2031–2040	2041–2050	Total for 2041–2050	Total for the life cycle
Renovated buildings	units	99 281	156 141	180 587	**436 008**	436 008
Renovated buildings	thousand m^2	27 819	39 414	42 301	**109 534**	109 534
Investment	EUR million	11 603	20 714	27 667	**59 985**	59 985
Primary energy savings	GWh	30 799	107 394	202 883	**341 076**	739 949
Reduced CO2 emissions	$ktCO_2$	6 504	22 803	43 261	**72 569**	157 947
Benefits assessed in the evaluation of the most cost-effective renovation method						
FN1. Value of energy savings (renovation)	EUR million	1 235	4 736	9 390	**15 360**	33 323
FN2. Value of reduced CO2 emissions (renovation)	EUR million	185	1 024	3 297	**4 506**	9 807
EN1. Increase in GDP	EUR million	5 801	10 357	13 834	**29 992**	29 992
Total:	EUR million	7 221	16 117	26 520	**49 859**	73 123
Additional monetisable benefits						
EN2. Improved human health and working capacity	EUR million	3 771	6 732	8 992	**19 495**	19 495
EN3. Increase in the value of residential	EUR	831	1 615	2 083	**4 529**	4 529

[43] https://www.embuild.eu/knowledge-center/wider-benefits/
[44] Undiscounted value

housing	million					
EN4. Reduction of pollution	EUR million	55	288	857	**1 201**	2 606
EN5. Reduced allowances	EUR million	32	89	147	**268**	268
Total, including additional benefits:	**EUR million**	**11 910**	**24 842**	**38,600**	**75 351**	**100 020**

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

To summarise the above data, it can be observed that:

- a significant share of the benefits is transferred to the period after the renovation implementation (after 2050), e.g. a building renovated in 2050 will save energy at least until 2079;
- even over the implementation period of the renovation strategy (2021-2050), the additional benefits outweigh the investments, i.e. the investments pay off;
- the wider benefits are significantly higher than the direct benefits of renovation in terms of energy savings and CO_2 emissions over all the time periods assessed;
- wider benefit calculations provide a cumulative result of all benefits to all beneficiaries (the owner of the building, the state budget, other citizens, etc.). When evaluating the results of the benefit calculation from the perspective of an individual beneficiary, they may differ;
- the assessment of the renovation investment does not take into account the fact that part of the investment in the buildings must be made to continue its use (even without renovation). Such an assessment is likely to result in lower renovation investments.

A description of the wider calculation of benefits is given below.

N1. Reduction of energy consumption

The main objective of the renovation of the building stock is to reduce the energy costs of the building, which, through reduced bills, directly benefit consumers financially.

The renovation programme, which would renovate 60% of the energy saved during the LTRS implementation period, would have a financial value of EUR 15.4 billion.

N2. Reduced CO_2 emissions

GHGs have a negative impact on the environment through the greenhouse effect, increasing acidity of the oceans and consequent other environmental changes that alter the ecological balance.

The entire building stock consumes 40.8 TWh of energy per year, resulting in 5.3 ž million tonnes of CO_2 emissions per year. Reducing primary energy consumption by ~60% is expected to reduce CO_2 emissions by 3.8 million tonnes, or ~70% per year.

In addition, CO_2 emissions would become zero if the following conditions are met:

- the electricity sector will transform 100% into a zero CO_2 emission sector;
- the DH sector will transform 100% into a zero CO_2 emission sector;
- all buildings in the building stock not connected to DH would relinquish individual production sources using fossil fuels.

In accordance with the Recommendations, the value of CO_2 savings was assessed based on the carbon dioxide emission price forecast published by the European Commission, an effective technology (joint action, low fossil fuel prices) scenario in which the CO_2 price would increase from EUR 25/t CO_2 emissions in 2020 to EUR 147/t CO_2 emissions in 2050.

As a result, it is estimated that at least EUR 4.5 billion in benefits would accrue over the lifetime of the LTRS because of reduced CO_2 emissions.

N3. Increase in GDP

The renovation of the national building stock has a multidimensional impact on the national economy:

- investments in the renovation of buildings lead to an increase in the quantity of purchased materials required for the renovation. The economic impact depends on the renovation package chosen, the complexity of the measures, the possibilities for automation and the availability of local production.
- the renovation directly and indirectly increases the employment of the local population. An investment of EUR 1 million per year is estimated to create between 19 and 37 jobs[45]. The number of jobs depends on the renovation package chosen, the complexity of the measures, and the possibilities for automation.
- renovation reduces the import of energy resources, i.e. the trade deficit. Gas remains an important energy source for building heating. Liquid fuels of petroleum origin remain essential for the collection and logistics of timber fuels. Accordingly, the increased energy efficiency of buildings reduces the import of foreign products, trade deficit, and contributes to the growth of the local economy and increased energy security, in particular during the cold seasons, when the reserve DH heat production capacities are switched to cover the increased heating needs.

According to a study by Copenhagen Economics[46], an average renovation investment of EUR 1 billion into renovation adds EUR 0.88–1.06 billion to a country's GDP in the EU countries. No such assessment has been carried out for the Lithuanian market. Based on the principle of conservatism, it is estimated that an investment of EUR 1 in renovation will increase the country's GDP by EUR 0.5.

N4. Improved health and working capacity of the population

Better heat insulation, more efficient heating and cooling systems, better indoor lighting and a better ventilation system have a positive impact on health and productivity. Renovation eliminates problems such as insufficient indoor temperature, humidity, insufficient air change and/or insufficient lighting.

According to the BPIE study[47] 'How to integrate indoor environmental quality into national long-term renovation strategies', numerous scientific studies show that indoor environmental quality has a direct impact on health, comfort, well-being, and productivity. Studies have shown that the number of respiratory and circulatory hospitalizations has been reduced by insulation of homes, mainly due to the provision of adequate indoor temperature. Cold houses are also often wet, which can lead to the growth of mould, which causes respiratory diseases. Improved indoor lighting and ventilation improves the indoor climate of office and science buildings, which is likely to increase productivity by improving the work and learning opportunities of students and students and their productivity.

Most energy efficiency improvement measures ensure the required indoor temperature in accordance with hygiene standards, and the choice of renovation measures that also improve the indoor climate can bring health benefits due to:

- lower morbidity;
- lower mortality;
- increased productivity of workers;
- improvement in the overall quality of life.

---

[45] https://www.copenhageneconomics.com/publications/publication/multiple-benefits-of-investing-in-energy-efficient-renovation-of-buildings

[46] https://www.copenhageneconomics.com/publications/publication/multiple-benefits-of-investing-in-energy-efficient-renovation-of-buildings

[47] http://www.bpie.eu/publication/policy-paper-how-to-integrate-indoor-environmental-quality-within-national-long-term-renovation-strategies/

The state budget balance is also improving due to better health of the population:

- public expenditure will be reduced due to lower health care costs;
- the state budget can be supplemented, as employees will be less ill and more able to work for more days (lower costs for compensation of lost income and higher income from wages).

Projects aimed at improving the energy performance of buildings typically include insulation work on façades and roofs, replacement of windows and renovation of heating systems. They can have two effects: firstly, an increase in indoor temperature and the resulting increase in comfort and, secondly, a reduction in energy consumption costs. In Lithuania, the normal temperature in non-renovated buildings during the cold season is 18°C, which is the minimum temperature recommended by Lithuanian legislation and the World Health Organisation, but buildings with poor energy efficiency may not always be able to ensure this temperature. Higher temperatures in rooms with poor energy performance are often avoided for lower energy bills.

In this context, renovation, depending on the specific interventions, may lead not only to a reduction in energy consumption costs, but also to an increase in indoor temperature and, consequently, in comfort. In Lithuania, renovated buildings are normally maintained at an average air temperature of 20–22°C, if the residents or users of the buildings are unable to individually regulate the temperature of each apartment / room, and 18–25°C, if the users are free to regulate the temperature of the premises, considering their wishes, outdoor temperature and economic opportunities.

To assess the benefits of renovation in terms of its positive impact on health and work capacity, a study by Copenhagen Economics[48] 'The multiple benefits of re-investing in energy-efficient buildings' were used. This study estimated that the average health and employability benefits vary from EUR 1.05 to 2.2 billion per year for every EUR 1 billion invested. Considering the lower income of the population in Lithuania and following the principle of conservatism, it is assumed that these coefficients will be five times lower in Lithuania and will amount to between EUR 0.21 and 0.44 billion for every EUR 1 billion invested. The average of these values is EUR 0.325 per euro invested.

Considering the planned investments in the implementation of the LTRS, it is estimated that the social benefits from improved health and work capacity of the population will amount to EUR 19.5 billion over the period of 2021–2050.

N5. Growth in the value of residential real estate

According to the real estate price statistics[49] provided by the real estate agency Ober-haus, residents tend to pay between 10 and 33% more for an apartment in a renovated house. To summarise the results of the BETA surveys on population opinion[50], it can be stated that, apart from the reasons for lower heating costs and an aesthetically better picture, buyers are prepared to pay more for the renovated residential property because they believe that there is a risk of not agreeing and implementing a renovation project in the non-renovated house, as well as a willingness to pay extra for the fact that they would not have to live in the renovated object during the renovation, for the longer life expectancy of the renovated object's structures and for greater comfort.

The impact of the growth of the real estate value of residential real estate was calculated as follows:

- the estimated area (m^2) of residential buildings renovated during the LTRS implementation period in the five largest cities of Lithuania: Vilnius, Kaunas, Klaipėda, Šiauliai, and Panevėžys (33.1 million m^2);
- the average market price for residential housing in each city (EUR/m^2);

Table 62. Average market value of residential real estate in major Lithuanian cities

City	Unit of measure	Market value
Vilnius	EUR/m^2	1 600
Kaunas	EUR/m^2	1 270

[48] https://www.copenhageneconomics.com/publications/publication/multiple-benefits-of-investing-in-energy-efficient-renovation-of-buildings

[49] https://www.ober-haus.lt/rinkos_apzvalga/nekilnojamojo-turto-kainos-2020-m-geguzes-men/

[50] http://www.betalt.lt/veiklos-sritys/programos/daugiabuciu-namu-atnaujinimo-modernizavimo-programa/102?c-19/t-46

Klaipėda	EUR/m^2	1 280
Šiauliai	EUR/m^2	870
Panevėžys	EUR/m^2	870

Source: Ober-haus

- the impact of the renovation on the value of the dwelling has been determined. In line with the conservatism principle, the lower limit is 10%.

It is estimated that over the LTRS implementation period, residential property value growth would generate at least EUR 4 529 in benefits in the five largest Lithuanian cities alone.

N6. Impact of the renovation of the building stock on pollution

To meet the energy needs of building households, other pollutants than GHG emissions are also formed: carbon monoxide (CO), nitrogen compounds (NO_x), sulphur dioxide (SO_2) and particulate matter (PM). Unlike GHG emissions, the impact of these pollutants is most pronounced where emissions occur – in cities, residential blocks or industrial parks where solid fuels are heavily used. These pollutants have a significant negative impact on the environment and human health: worsening air quality indicators can increase the number of patients suffering from respiratory diseases (tracheitis, bronchitis, bronchial asthma, other chronic respiratory diseases, or their exacerbation).

The impact of the reduction of air pollution was calculated as follows:

- estimated primary energy savings (GWh) by five types of production/fuel: DH, natural gas, biofuel, electricity, other fuels. The fuel mix of DH is estimated to be biofuels (80%) and natural gas (20%). Other fuel structure: liquid fuel (50%), liquefied natural gas (10%), coal (10%), peat (30%);
- emission factors (g/kWh) for each fuel assessed (CO, NO_x, SO_2 and PM). The assessment was based on the European Environment Protection Agency's methodology for atmospheric pollutant emission inventory *EMEP/EEA air pollutant emission inventory guidebook – 2016*, Chapter 1.A.4 *Small Combustion*; the methodology was approved by the Order No D1-378 of the Minister for the Environment of the Republic of Lithuania of 15 July 2005 approving the list of the methodologies of the calculation of the amount of pollutants emission to the atmosphere, and determination of the amount of the emission of taxable pollutants to for persons who do not keep the compulsory inventory of pollutant emissions;

Table 63. Emission factors

No	Source of production	Unit of measure	NO_x	SO_2	PD
1.	DH	g/kWh	46.1	5.5	87.6
2.	Natural gas	g/kWh	0.142	0.001	–
3.	Biofuel	g/kWh	0.156	0.04	1.04
4.	Electricity	g/kWh	1.82	1.67	–
5.	Solid fuels	g/kWh	0.45	1.56	0.68

Source: The authors of the study to develop the long-term renovation strategy of Lithuania, based on the European Environmental Agency

- calculated emissions over the period (t);
- determined pollution costs for each pollutant assessed (EUR/t);
- estimated pollution avoided during the assessment period (EUR).

It is estimated that EUR 1.201 billion in air pollution will be prevented over the lifetime of the LTRS.

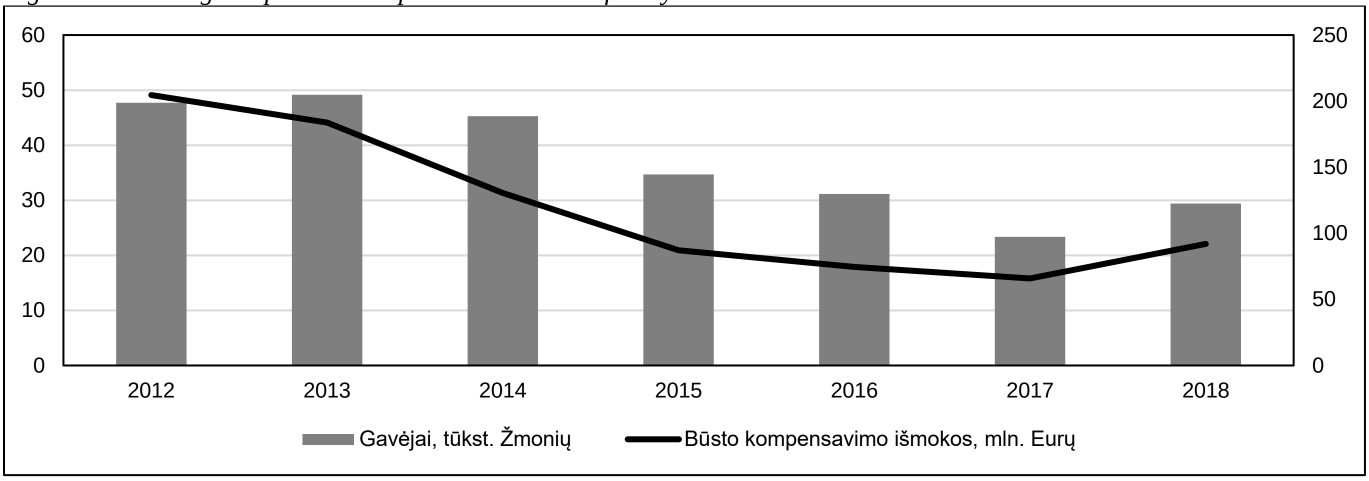
N7. Reduced compensation for heating costs of the vulnerable population group

Currently, in Lithuania, poor people are compensated for the costs of heating, drinking and hot water. For the non-deprived, the part of the home heating costs that exceeds 10% of the difference between the family's (person's) income and the amount of the state supported income (SSI) for the family (person) is reimbursed. In 2019, the SSI amounted to EUR 122. For example, if the household income amounts to EUR 800 and the heating bill amounts to

EUR 100, the heating bill is reimbursed for about EUR 70, i.e. the consumer's heating costs may not exceed EUR 31.2[51].

The figure below shows the statistics of the heating compensation payments budget in 2012-2018. The demand for compensation is influenced by three main factors: heat consumption, heat prices and household income. The main effect of the renovation is a decrease in thermal energy demand.

Figure 27. Housing compensation expenditure and beneficiary levels 2012-–2018 in Lithuania



Source: The Ministry of Social Security and Labour of the Republic of Lithuania

Accordingly, the reduction of the compensation for heating was calculated as follows:

- the annual compensation requirement was set at EUR 21.6 million;
- whereas by 2050, all buildings in energy performance class C or lower will be renovated, and in line with the conservatism principle, it is estimated that by 2050, 80% of the compensation will have disappeared, i.e. on average EUR 0.58 million per year will no longer be needed;
- savings of EUR 267.8 million over the period of implementation of the LTRS for heating compensations.

5.3.2. Co-benefits

In addition to the calculated benefits described above, there are other, non-quantifiable benefits that are difficult to assess due to their nature or lack of data. The following is an overview of the most significant wider benefits:

- energy independence;
- utilisation of existing production capacity;
- increase in the service life of buildings;
- reduction in the need for subsidies in the sectors concerned;
- strengthening of the sector of manufacturers of construction and building materials.

Energy independence

Energy-efficient buildings significantly reduce energy demand, in particular during extreme cold periods, when the dependence on imported energy resources (in Lithuania – natural gas) is the highest, and the society is the most vulnerable. In addition, the lower demand for imported resources is one of the factors contributing to faster economic growth.

[51] (EUR 800 – (EUR 122 x 4) x 10% = EUR 31.2. Costs in excess of this amount will be reimbursed.

Greater energy independence also implies greater resilience to external fluctuations in the price or supply of energy resources caused by global economic or political events. In such a case, not only the stability of the country's economy is ensured, but also the strength of the country's business and society despite global events, and the country's competitive advantage arises in the event of changes in the energy resources market.

Lower investment in production capacity

Energy efficient buildings require less thermal energy to heat the building. This means that even as the density of building construction is increasing in cities, there is no need to increase the production and supply capacity of energy resources (natural gas, DH or electricity) due to more efficient consumption.

Additional benefits can be achieved by implementing the district renovation of buildings and, at the same time, by upgrading the energy supply infrastructure, e.g. by renewing the heat distribution in the DH district.

Increase in the service life of buildings

Renovation not only reduces the energy costs of buildings, but also protects building structures from atmospheric influences, thus prolonging their service life. Also, the roof, windows, electrical wiring, piping, and heat station are frequently replaced during the renovation. All these building engineering systems are often worn out and require constant costs for repairs, or put people's health and property at risk (e.g. water pipe rupture, roof leaks, unstable power supply or worn wire insulation that could result in fire, crushing façades or balconies that could injure people or damage cars).

Reduction in the need for subsidies

Currently, both fossil fuel consumption and the introduction of RES technologies are subsidised in Lithuania and other European Union countries. Reducing energy consumption through efficient building renovation can reduce both types of subsidies. This will have a positive impact on public finances. These funds could be channelled into other areas, such as promoting investment in low-carbon technologies, including energy efficiency, to achieve stricter targets for reducing the impact of human impacts on climate change in the future.

Growth in other sectors and new businesses

Significant increases in the need for investment and other resources due to renovation may act as a catalyst for the creation or growth of businesses in other sectors. An example of such an impetus in Lithuania is the conversion of DH thermal energy production from natural gas to biofuel. Since the start of the transition from natural gas as the main fuel in 2007, there were no strong companies engaged in the production of biofuel boilers, while the use of domestic fuel in DH amounted to 16%. However, when the level of biofuel use in DH reached 67% in 2019, strong groups of biofuel boiler manufacturers and biofuel suppliers were formed. Biofuel boiler manufacturers provide solutions for heating both DH and individual buildings. Also, companies in both sectors export their services abroad.

With the renovation of buildings, a similar result could be achieved in Lithuania by creating strong companies offering solutions and services for the renovation of buildings. One of these solutions could be panel renovation technology, where according to accurate building drawings panels could be manufactured in Lithuania, where labour costs are lower, and later exported abroad.

5.4. ESSENTIAL OBSERVATIONS OF THE CHAPTER

- ✓ The renovation Strategy targets a reduction in the annual building stock by 2050 compared to 2020:
  - o to reduce the primary energy consumption to 16.2 TWh (60%);
  - o to eliminate primary energy from fossil fuels;
  - o to achieve zero CO_2 emissions.
- ✓ Achieving these targets will reduce the share of inefficient buildings in total primary energy consumption from 77% to 23%.
- ✓ The building stock, as an energy consumer, is an integral part of the energy sector; therefore, the target

indicators assume that the transformation of both the building stock (energy consumption) and the energy sector (energy production) will be implemented, i.e. both DH and electricity production will account for at least 100% of RES.

- ✓ Most of the savings in primary energy (39%) and reductions of CO_2 emissions (30%) will be achieved in private houses, the remainder in multi-apartment buildings (25% and 24%, respectively), other non-residential buildings (20% and 24%), and industrial buildings (16% and 22%).
- ✓ To achieve the renovation indicators, almost 440 thousand buildings (74%) will have to be renovated.
- ✓ The renovation strategy will require an investment of EUR 60 billion by 2050. In the same period, however, the benefits will significantly exceed the investments and amount to EUR 75.3 billion.

6. ROADMAP FOR THE RENOVATION STRATEGY

Article 2a(2) of the EPBD provides that 'In its long-term renovation strategy, each Member State shall set out a roadmap with measures and domestically established measurable progress indicators, with a view to the long-term 2050 goal of reducing greenhouse gas emissions in the Union by 80–95% compared to 1990, to ensure a highly energy efficient and decarbonised national building stock and to facilitate the cost-effective transformation of existing buildings into nearly zero-energy buildings. The roadmap shall include indicative milestones for 2030, 2040 and 2050, and specify how they contribute to achieving the Union's energy efficiency targets in accordance with Directive 2012/27/EU.'.

Article 2a(3) of the EPBD provides that 'To support the mobilisation of investments into the renovation needed to achieve the goals referred to in paragraph 1, Member States shall facilitate access to appropriate mechanisms for:

(a) the aggregation of projects, including by investment platforms or groups, and by consortia of small and medium-sized enterprises, to enable investor access as well as packaged solutions for potential clients;

(b) the reduction of the perceived risk of energy efficiency operations for investors and the private sector;

(c) the use of public funding to leverage additional private-sector investment or address specific market failures;

(d) guiding investments into an energy efficient public building stock, in line with Eurostat guidance; and

(e) accessible and transparent advisory tools, such as one-stop-shops for consumers and energy advisory services, on relevant energy efficiency renovations and financing instruments.'

Information on the transformation indicators of the building stock and the benefits to be achieved is provided in Chapter 5. Specific measures for the implementation of the transformation, the resources and funding mechanisms necessary for their implementation will be specified in the LTRS Implementation Plan 2021–2030.

This chapter provides information on the principal model for the implementation of the renovation strategy based on which the LTRS Implementation Plan 2021–2030 would be developed.

The development of the principal model for the implementation of the renovation strategy sought to:

- Identify the critical factors (success factors) for the implementation of the strategy necessary to eliminate or reduce the identified renovation barriers (see Chapter 4) to an acceptable level to achieve the objectives;
- shape the implementation process and measures in such a way that the transformation of the building stock is sustainable, complex and reflects the essential provisions of the European Green Deal, focusing both on the specific transformation objectives of the building stock (see figure below) and other wider benefits highlighted in the European Green Deal (e.g. ensuring the transformation of the building stock in accordance with the principles of universal design, coherence with biodiversity protection objectives).

The results of the analysis of the renovation barriers have confirmed the conclusion of numerous studies and studies that the renovation process is extremely fragmented and therefore difficult to transform. The fragmentation of the renovation process is manifested by the fact that many different countries with different interests participate in the process and, consequently, different barriers hindering the decisions necessary for the rapid and effective implementation of the renovation.

The action plan of the initiative Renovation Wave identifies the following key stakeholders and groups of actors in the renovation process and their respective responsibilities in the renovation process:

Table 64. Parties to the renovation process and responsibilities

Country	Responsibility for breakthrough in renovation
Ministries, Government level	Adopts a long-term renovation strategy, tightens minimum energy performance requirements, sets requirements for buildings under renovation, renovates state-owned buildings, carries out integrated planning and national communication
Local self-government level	Ensures that the renovation is carried out not in individual buildings, but in larger groups together with the reconstruction of utility networks, carries out the renovation of municipal buildings, establishes one-stop consultation centres providing information on all possible renovation possibilities, collects data on the building stock and its characteristics
Financial sector	Ensures the development of energy efficiency competencies, assesses and combines technical and financial risks, adds environmental, social and management criteria to the financial assessment, develops and offers standard financial products for renovation
Designers	Design new products for specific renovation using all possible tools and technologies for new buildings
RP developers	Ensure the construction process without unnecessary waste of resources, invests in innovations, engages in the development, production and use of prefabricated renovation products
Energy suppliers	Provide transparent information on energy consumption to both consumers (for making renovation decisions) and municipalities and analysts, reviews their business model with a view to becoming a service provider rather than an energy unit (kWh)
Building owners	In accordance with the available information and requirements, decides on the fact, time and scope of the implementation of the renovation.

Source: Action Plan of the initiative Renovation Wave

In addition to the countries mentioned in the table above, housing managers and organisations uniting housing managers may also be a party to the renovation process in Lithuania, as countries may cooperate between residents and other institutions to disseminate information about the benefits of renovation to residents.

All parties involved in the renovation process mentioned in the table above are important and play a role in the different stages of the renovation, the most important party without which the renovation cannot take place is the owner of the building.

To achieve the renovation targets set out in Chapter 5, ~80% of the units of the current building stock must participate in the renovation. In Lithuania, only 2% of the ownership of the building stock is public (state or municipal ownership). The remaining property is private (i.e. owned by natural persons or legal entities) and is not significantly concentrated in terms of ownership: 2/3 of the buildings are multi-apartment buildings and individual houses, which are largely owned by natural persons.

To get a breakthrough, the benefits of renovation need to be convincing to most building owners. To achieve this result, the LTRS implementation model needs to be focused on the building owner, their expectations, and the removal of key obstacles hindering their decision to participate in renovation.

The orientation of the LTRS implementation model towards the building owner is a critical factor in the implementation of the strategy, based on which the strategy implementation model is formed.

6.1. MODEL FOR IMPLEMENTING THE STRATEGY

To effectively implement the strategy implementation model focused on the building owner, it is important to be able to assess the renovation from the owner's perspective.

Various studies and surveys present different expectations of building owners, and the typical obstacles that hinder owners' decision to participate in renovation. However, to summarise, for a building owner to participate in a renovation, they have to believe in the benefits of the renovation, i.e. that the benefits of the renovation will outweigh their investment.

For a building owner to believe in the benefits of renovation:

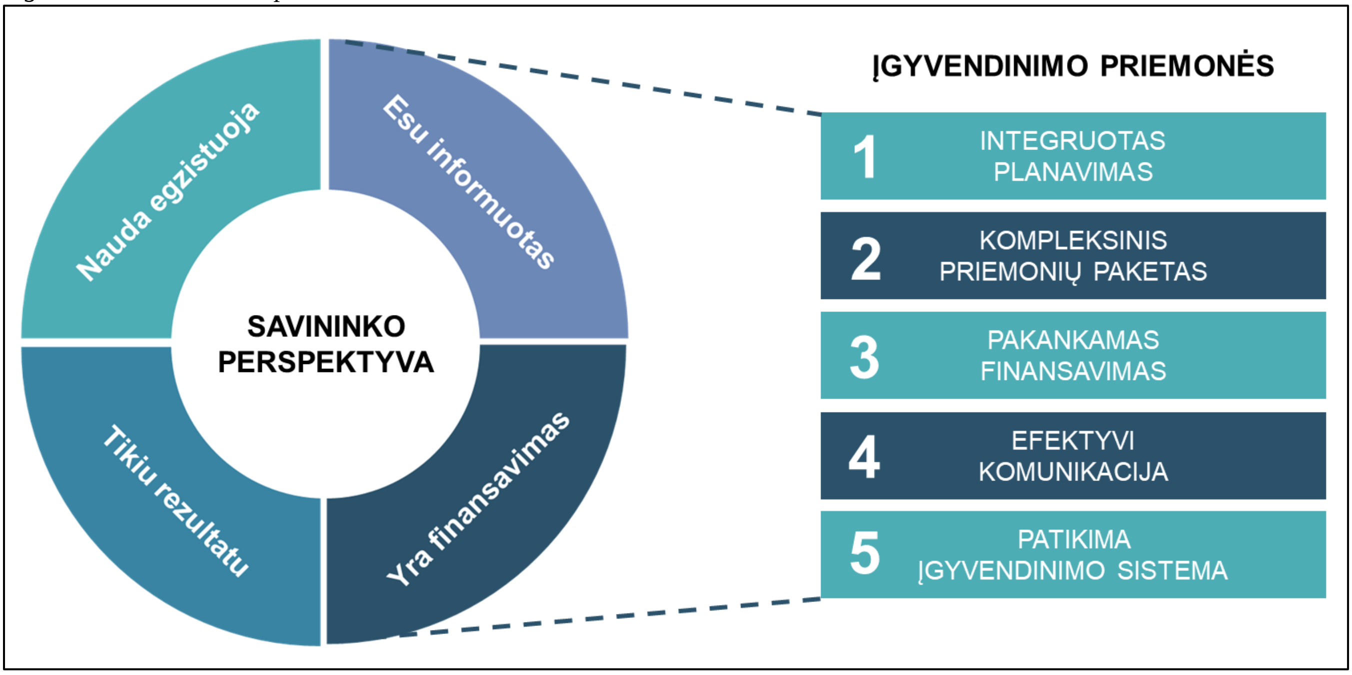
- benefits to the owner must be available objectively;
- the owner must be informed of the benefits – it is important to assess that the owner's investment is financial, and the benefits of renovation are multifaceted (not only energy savings and reduced costs, but also increase in housing value, improved social environment, etc.); therefore, the owner must be made aware of the full range of opportunities and benefits of renovation. It is also critical to communicate that, in the long term, engineering worn out, energy inefficient buildings have no choice to participate or not to participate in renovation. The only choice for the owner is whether to carry out the renovation with the state support;
- attractive financing solutions must be available – even if a building owner hopes to benefit from the renovation, they will not participate if they do not have the financial means to do so;
- there must be reasonable assurance of the effectuation of the benefits of the renovation – even if a building owner expects to benefit from the renovation and has attractive financing options, they are unlikely to participate in the renovation if they do not believe that the intended result will be achieved.

The principal measures that should lead to a breakthrough in the renovation are presented below.

1. **Integrated planning and monitoring**: to maximise the benefits of renovation, to harmonise support measures and to ensure a smooth process, it is important to plan and coordinate both the parts of the renovation process itself and its links with other areas (e.g. energy, spatial planning).
2. **Comprehensive package of support measures**: for owners to believe in the benefits of renovation and to participate in renovation at a sufficient pace, we have to apply complex motivational measures (both incentives and penalties) that focus on maximising benefits.
3. **Adequate funding**: adequate funding is required for owners to be willing and able to contribute to renovation investments.
4. **Effective communication**: for the owners of buildings, as beneficiaries, and other parties involved to be aware of these measures, clear, smooth, coordinated and timely communication must take place.
5. **Reliable implementation system**: to ensure a smooth process and to take into account the needs of building owners, it is necessary to approach building owners both physically and in response to their needs.

The figure below shows a schematic diagram of the renovation strategy implementation model oriented towards the building owner.

Figure 28. Renovation implementation model



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

6.2. MEASURES OF IMPLEMENTATION OF THE STRATEGY

The table below provides a list of the planned measures and actions necessary for the implementation of the renovation strategy.

Table 65. List of the renovation strategy's implementing measures and actions

Measure	Actions
P1. Integrated planning and monitoring	**P1. Coordinated interinstitutional planning** Coordinated planning of all energy efficiency and RES measures between different authorities
	P2. Inventory of the building stock and systematisation of data Establishment of a common database, validation of the process for collecting and updating information
	P3. Integration of the renovation indicators into the legislative framework Harmonisation of the LTRS with other strategies, the NECP, and other legislation
	P4. A stronger role for the local self-government level Integration of the LTRS indicators into the local self-government level, validation of the role of municipalities
	P5. Monitoring systems Establishment of a monitoring system
P2. Comprehensive package of support measures	**P6. Full price of energy** Reducing energy price subsidies
	P7. Pollution taxes Taxation of pollution (CO_2 emissions), and/or increased energy consumption
	P8. Promoting deep renovation Financial incentives dependent on energy savings (higher savings = higher support)
	P9. Promoting rational renovation Rational sequencing of RES and EE measures
	P10. Targeted zero CO_2 emissions Coordinated interinstitutional efforts, a well-targeted and balanced system of incentives and penalties, and wide-ranging monitoring of external factors
	P11. Promoting district renovation

Measure	Actions
	Grouping/aggregation of buildings in combination with infrastructure and well-being renovation
	P12. Promoting partial renovation Financing of individual renovation measures carried out by owners of private houses
	P13. Aggregation of renovation projects Combining projects to achieve economies of scale in implementation and financing
	P14. Ensuring sustainability and innovation Promoting sustainability and innovation and mainstreaming in the implementation of renovation
	P15. Management of minimum requirements EPC requirements, mandatory technical solutions, etc.
P3. Adequate financing	**P16. Ensuring funding** Ensuring sufficient funding
P4. Effective communication	**P17. Communicating the inevitability of renovation** Strategic communication on renovation indicators and commitments
	P18. Communication on the benefits and measures of renovation Communication on renovation benefits, opportunities, and support measures
P5. Reliable implementation system	**P19. Implementation of the one-stop shop** Setting up customer service centres
	P20. Establishment of a competence centre Development of good practices and standardised documents/ processes
	P21. Ensuring maintenance Approval and enforcement of maintenance requirements

Source: The authors of the study to develop the long-term renovation strategy of Lithuania

The following is a description of the proposed renovation strategy's implementing measures and the actions that will underpin the implementation of the LTRS.

6.2.1. Integrated planning

The transformation of the building stock projected in the LTRS requires basic, managerial decisions in the planning stage:

- integration of the LTRS indicators into the legislative framework;
- establishment of an interinstitutional organisational unit to act as the LTRS project manager, i.e. responsible for planning, coordinating, and monitoring the implementation of the LTRS;
- development of comprehensive package of support measures;
- elaboration of the LTRS indicators at the municipal level, and delegation the responsibility to municipalities for their implementation, by providing the necessary funding;
- establishment of a monitoring system and ensure periodic updating of the target indicators in line with progress in implementation.

P1. Coordinated interinstitutional planning

The renovation of buildings involves different stakeholders, renovation has a direct impact on related sectors (e.g. energy infrastructure planning, urban planning, regional development planning, social welfare, etc.), and the targets set by the LTRS are directly dependent on the scenarios of the energy sector. In addition, the support measures related to the renovation of buildings are currently planned and administered by different institutions, and the sources of financing for the measures (funds) differ. Accordingly, the conditions for the selection and financing of measures and the implementation periods differ, which complicates the possibilities of the integrated application of such measures (for example, energy efficiency of buildings is not assessed in support of the introduction of RES measures or financing is sufficient for only a part of activities in the context of block renovation).

to ensure coordinated and systematic planning and implementation, it would be useful to set up an organisational unit responsible for implementing the long-term renovation strategy (e.g. an interinstitutional working group/committee), whose members would represent all the main stakeholders. The working group would carry out the functions of the LTRS project manager, i.e. within the limits of its mandate, would be responsible for the identification, review and updating of LTRS indicators, the compatibility of the LTRS with other energy efficiency and RES promotion policy measures and energy sector planning, such as the planning of block renovation, where renovation support measures should be further coordinated with site management and development measures.

Problem to be solved (barriers)	B1. Insufficient interinstitutional coordination B19. Restrictions on the workforce in the construction sector
Proposed measure	Establishment of an inter-institutional LTRS working group
Priority	High
Implementation perspective	Short-term period

P2. Inventory of the building stock and creation of a database

Currently, there is no comprehensive data source for information on the characteristics, technical condition and actual energy consumption of buildings. The lack of data complicates the establishment of LTRS indicators and the monitoring of their implementation.

The requirement for adequate data is also set out in the Amending Directive, which states in a recital that 'High-quality data on the building stock is needed and this could be partially generated by the databases that almost all Member States are currently developing and managing for energy performance certificates.'

The creation and collection of data should be carried out by complex means: by providing for the obligation to carry out energy audits before and after the renovation of a building, developing a methodology for the conversion/comparison of the calculated energy consumption in buildings with the actual primary energy data for the relevant period, introducing a system of building passports, and drawing up maps of the building stock, etc. (see example of good practice below). To ensure the long-term functioning of such a database, it is necessary to establish clear processes for the standardisation, collection, processing and use of data, to appoint a specific long-term administrator and source of financing for such a database, and to grant the administrator the necessary data access rights (e.g. the power to collect certain data from energy suppliers).

The problem to be solved	B2. Unreliable (asymmetric) information
Proposed measure	Development of the LTRS database integrated with the main data sources, development of data on energy consumption
Priority	High
Implementation perspective	Short- to medium-term period
Examples of good practice	Map of Vilnius Quarterly Renovation Buildings Analysis tools of the building stock (EmBuild)

P3. Integration of the LTRS indicators into the legislative framework

The targets set in the LTRS must be properly integrated into both the strategy papers at national level (vertical integration upwards) and the strategic and operational papers of the authorities responsible for implementing the LTRS (vertical integration downwards) and the sectors concerned (horizontal integration).

It is appropriate to integrate the LTRS indicators into the Climate Change Strategy and other strategic planning documents. According to the EU Directives, the long-term renovation strategy is part of the NECP. The NECP, in turn, is the main document declaring Lithuania's objectives in the areas of energy efficiency and RES. As the NECP was adopted earlier and has a shorter time horizon (up to 2030), it does not reflect the more ambitious LTRS. The National Progress Programme is the main national strategic document integrating the objectives and indicators to be achieved in different areas.

The problem to be solved	B1. Insufficient interinstitutional coordination
Proposed measure	Updating related legislation
Priority	High
Implementation perspective	Short-term period

P4. A stronger role for the local self-government level

Different segments of the building stock have different needs, requiring different renovation measures to realise those benefits. For these needs to be systematically heard and implemented, a more active involvement of the local self-government level is required (i.e. the management level closest to the consumer, which knows the consumer best). Moreover, the lessons learned from the multi-apartment renovation programme show that it is the local self-government abilities and motivation that are critical factors for the success of the renovation or, conversely, the barriers.

To enable a more active involvement of local self-government, the formalization of the model of the role and responsibilities of local self-government is necessary by choosing the format of the obligation (e.g. by providing for new obligations in the Law of the Republic of Lithuania on Local Self-Government) or the agreement (e.g. by signing agreements with each municipality), as well as by establishing obligations related to the implementation of the LTRS, e.g. to collect data on the municipal building stock (see Measure P2), to draw up municipal LTRS implementation plans, to implement the one-stop-shop principle (see P18), etc. The responsibilities should be accompanied by a funding mechanism for the model.

The RES target-setting model could be used as a model for mechanisation[52]: the Law of the Republic of Lithuania on Energy from Renewable Sources provides that the Government of the Republic of Lithuania shall establish the minimum mandatory targets for the achievement of the targets for the use of energy from renewable sources and shall coordinate the draft action plans for the development of the use of RES by municipalities. Accordingly, municipal lower-level planning documents should be coordinated and / or integrated: municipal RES use development action plans, municipal heat sector specific plans, etc.

The problem to be solved	B2. Unreliable (asymmetric) information B3. Insufficient involvement of local government
Proposed measure	Integration of the LTRS indicators into the municipal planning documents
Priority	High
Implementation perspective	Medium-term

P5. Monitoring system

The LTRS is a long-term planning document, which will be updated periodically, considering the results achieved, lessons learned, new construction technologies and solutions, EU-wide initiatives, the changing economic, social and other situation of the country and other factors of the internal or external environment. Data will also be required for the LTRS progress reports. Accordingly, in addition to the inventory of the building stock and the creation of a database (measure P2), there is a need to adapt these data for the monitoring of the LTRS (both methodically and by creating the necessary tools).

The problem to be solved	B3. Insufficient involvement of local self-government
Proposed measure	Development of the monitoring system (methodology and tools) for the implementation of the LTRS
Priority	High
Implementation perspective	Medium-term

[52] Separate measures for its implementation.

6.2.2. Comprehensive package of measures

When the planning stage is properly completed, a package of support measures that meets the LTRS indicators and is consumer-orientated must be formed, maximising the renovation costs. to achieve optimal energy efficiency in buildings, i.e. to maximise the benefits of renovation, two challenges should be addressed in an integrated manner. First, the depth of the renovation must be ensured, i.e. since the renovation is a long-term process, the aim should be to maximise energy savings by choosing to carry out the renovation. Secondly, the pace (scope) of renovation should be increased by ensuring the depth of the renovation.

When implementing complex energy efficiency projects, it is also relevant and especially important to adapt buildings and their environment for the disabled and the elderly in accordance with the principles of universal design, to address fire safety, hygiene, etc.

P6. Full price of energy

The motivation of building owners is directly related to the financial payback of renovation, which is mainly influenced by three factors: the price of energy, the price of renovation investments and the cost of servicing a loan for renovation (interest).

The price of energy is one of the most significant criteria, but at present it does not reflect full costs in Lithuania and is directly and indirectly subsidised:

- the exemption from VAT for heating;
- gas is subject to one of the EU lowest gas excise duties;
- reduced excise duty on diesel for heating;
- the costs of energy infrastructure upgraded from the EU structural funds are not included in the tariffs for consumers.

The reduced level of energy subsidies would improve the payback rates of renovation projects, increase the motivation of building owners to participate in renovation and would likely significantly reduce the need for subsidies for renovation measures. This is particularly relevant for predicting a consistent increase in the price level of renovation works and materials.

It is important to note that the implementation of such measures increases expenditure on heating, which, in turn, may increase energy poverty, social exclusion and the need for social assistance for the poor. The direct and indirect effects of the measure must therefore be assessed in advance. The issue of energy poverty could be addressed through targeted solutions (targeted support).

The problem to be solved	B4. Unattractive payback period for projects B5. Partial price of energy
Proposed measure	Inclusion of full costs in the energy price
Priority	High
Implementation perspective	Medium- to long-term period

P7. Pollution taxes

An additional measure to increase the financial payback of renovation is the taxation of energy inefficient and/or polluting energy consumption, e.g. by imposing an additional tax if the energy consumption of a building per square metre exceeds a certain number of kilowatt hours (e.g. 150) and/or a certain amount of CO2 emissions. This would consider not only energy efficiency, but also the fuel source (to avoid the use of fossil fuels). Other options for implementing this tax could include differentiation of the property tax according to energy consumption and/or CO2 emissions indicators, an additional tax on unmanaged buildings,

This tax could also significantly reduce the need for subsidies for renovation measures. When the need arises, the socially vulnerable should be supported through financial payments. Such a tax could also be collected not from the state budget, but virtually accrued to the owners of the same building and later used for the implementation of the renovation measure.

It is important to mention that a prerequisite for the implementation of such taxes is reliable data on the actual energy consumption and energy production of all buildings (see P2. Inventory of the building stock and creation of a database).

It is also important to note that the implementation of such measures increases building owners' expenses, which, in turn, may increase energy poverty, social exclusion and the need for social assistance for the poor. The direct and indirect effects of the measure must therefore be assessed in advance.

To enhance the impact of the pollution tax, the requirement to publish the data on the energy performance of buildings and the expected pollution tax in the advertisements for the lease or sale of property (the practice has been implemented in the automotive market by publishing the amounts of the pollution tax on sold cars) could be implemented.

The problem to be solved	B4. Unattractive payback period for projects B5. Partial price of energy
Proposed measure	Pollution taxes
Priority	High
Implementation perspective	Medium- to long-term period

P8. Promoting deep renovation

Support measures should be linked to the quality of the renovation work, considering the target or actual energy savings achieved because of the renovation. Support measures should be linked to energy performance, the level of compliance with certification or other specific requirements, energy audits or improvements achieved after the renovation, which should be assessed by applying one or more of the following criteria:

- the thermal characteristics of the equipment or materials used for the renovation (when the equipment used is installed by a certified or qualified installer);
- reduction of energy consumption;
- efficiency gains from the comparison of energy performance certificates issued before and after renovation;
- results of energy audits;
- the results of any other relevant, transparent and proportionate approach that demonstrates an increase in energy performance.

In implementing the provisions of the directives[53] and to create a mechanism of motivation for deep renovation, the amount of public support could be differentiated according to the energy savings to be achieved.

The problem to be solved	B7. Full potential of renovation benefits not realised
Proposed measure	Linking funding and intensity to energy saving objectives
Priority	High
Implementation perspective	Short-term period

P9. Promoting rational renovation

The provisions of the EU directives[54] stipulate that the LTRS must promote cost-effective renovation, i.e. support measures should be designed considering the rational use of resources to achieve the indicators set out in the LTRS.

Accordingly, the pursuit of rational (cost-effective) renovation should also be reflected in the support package being prepared, e.g. by setting cost-effective renovation standards and limiting the scope for investment financing. This would not limit the choice of the owner of the building to choose the technical solutions for the renovation he wants (e.g. a luxurious façade of the building), but the intensity of the financing of such investments would be proportionally lower than in the case of cost-effective investments.

---

[53] Article 10 of the EPBD.
[54] Article 2a(1)(b) and (c) of the EPBD

An analogous principle would be applied if the owner(s) of the building decided not to renovate the inefficient building, but to demolish it and construct a new one. The demolition of an existing building and the construction of a new building in the context of the targets set by the LTRS are an equivalent alternative to the renovation of a building to the same energy performance class, only with a significantly higher investment need. The beneficiary of substantial additional benefits related to the demolition of a building and the construction of a new building (e.g. increase in the value of housing) is the owner of the building. Accordingly, from the perspective of the implementation of the LTRS, the demolition of a building of energy performance class D and the construction of a new building of energy performance class A++ should be financed by the same amount (in absolute terms) as the renovation of that building to energy performance class A++. The need for additional investments should be financed by the owner of the building or other decisions (e.g. increasing the height of the building), or by other public financing programmes (e.g. when the state or local self-government decides to invest in urban coherence).

It is also important to consider when developing the support package that the principle of rational renovation also requires considering the order of application of the measures, e.g. only the part of the investment that would be necessary for an energy-efficient building should be financed when financing the acquisition (replacement) of energy production sources. Without considering this circumstance and starting the renovation of an energy inefficient building from the change of the energy production source (chosen based on the actual production capacity demand), it is likely that the subsequent investment in the building's tightness would render the installed production capacity excess and inefficient, and the investments made in the change of the production source economically unreasonable.

The problem to be solved	B7. Full potential of renovation benefits not realised
Proposed measure	Linking funding and intensity to the rational application of renovation measures
Priority	High
Implementation perspective	Medium-term

P10. Targeted zero CO_2 emissions

The goal to achieve zero CO_2 emissions in the building stock by 2050 requires the fulfilment of three essential conditions:

- the electricity sector is to be transformed 100% into a zero CO_2 emission sector;
- the DH sector is to be transformed 100% into a zero CO_2 emission sector;
- no buildings with an individual source of production using fossil fuels that are not connected to DH must remain in the current building stock (2020).

This indicator requires not only a coordinated interinstitutional effort and a well-targeted and balanced system of incentives and penalties, but also wider monitoring of external factors, such as:

- the RES technology evolution. Currently, a significant part of RES measures is not CO_2 neutral, therefore, even if all building production sources were changed to not using fossil fuels, CO_2 emissions would not be zero.
- Developments in sustainability-oriented policy instruments. For example, a change in the status of biofuels as a source of RES production would result in a significant share of current RES production sources becoming non-RES, etc.

Accordingly, to achieve zero CO_2 emissions, it is important to periodically assess not only the effectiveness of the measures taken, but also the changes in the external environment and to adjust the provisions of the LTRS accordingly.

The problem to be solved	Complex contribution of internal and external factors to zero CO2 emissions
Proposed measure	Periodic assessment of the effectiveness of the applied measures, monitoring of external factors and time in the LTRS.
Priority	High

Implementation perspective	Medium-term

P11. Implementing district renovation

During the quarter renovation, not only all street or district buildings, but also engineering systems and common areas are renovated. The result of the block renovation is a complex renovated block, which saves energy in the buildings and engineering systems of the block. In addition to the renovation of buildings, the lighting of the quarter, electricity and water supply and sewerage networks, DH networks, and the environment are renovated. This affects not only energy costs, but also the quality of life of the residents of the quarter. By renovating the whole district at the same time, the functionality of the district can be improved, for example, by preparing the electricity grid infrastructure to prepare parking places or to install charging stations for electric vehicles, thus encouraging the electrification of motor transport. It is also possible to adapt the courtyards to accommodate more cars and to make the green spaces more adapted to the needs of the population. The aesthetic view of the block is also important, which is easier to achieve during the implementation of the block renovation, because both the design and the ordering of materials take place at the same time. Buildings can be painted in one colour or in a palette of matched colours. The environment can also be managed in a unified way, depending on how the spaces are most convenient for residents to use.

Increased block functionality and a better aesthetic image increase the attractiveness of the block and the price of the property. Accordingly, block renovation can have a significant impact on the demand for renovation on the part of the owners due to the growing benefits: renovation of the block infrastructure, aesthetic view, growth of the value of the property.

Also, it is more efficient to ensure the realization of other wider transformation benefits, e.g. the sustainability of renovation, through large-scale complex renovation (see P14), adaptation of buildings and the environment in accordance with the principles of universal design, ensuring fire protection requirements, protection of biodiversity[55], etc.

In addition, block renovation can also be a supply-enhancing measure. Group renovation rather than one building at a time could attract major construction companies, which would reduce the cost and increase the efficiency of renovation. With the large renovation projects planned for the course of the year, specialized companies would develop, which carry out renovation works and develop their capacity accordingly, so that the supply of renovation services would meet the demand.

The problem to be solved	B7. Full potential of renovation benefits not realised B6. Renovation becoming more expensive B12. Reluctance of financial institutions to lend (limited lending possibilities)
Proposed measure	District renovation
Priority	High
Implementation perspective	Medium-term

P12. Implementing partial renovation

Partial renovation means the renovation of a part of a building or engineering systems with the shortest life span, e.g. replacement of windows, insulation and replacement of the roof, insulation of the rear walls of multi-apartment buildings, renovation of the heating system, etc. In line with the minimum achievable energy performance requirements, this measure would aim at increasing the interest of individual homeowners to renovate their homes.

In other segments of the building stock (e.g. the multi-apartment segment), partial renovation is only applied in cases when it is cost-effective and does not create additional barriers to the implementation of a deep renovation of a building.

The problem to be solved	B7. Full potential of renovation benefits not realised

55 Environmentalists ask to preserve swifts when renovating multi-apartment buildings | Ministry of the Environment of the Republic of Lithuania (lrv.lt)

	B20. Insufficient motivation of public building managers
Proposed measure	Implementing partial renovation
Priority	High
Implementation perspective	Medium-term
Good practices	[Compensation for renovation of private houses (EPMA)]

P13. Aggregation of renovation projects

Aggregation (merging) of individual renovation projects into one package solves several tasks and eliminates the disturbance of renovation. First, the merging of projects is related to the formation of the market supply (motivation of construction companies). By increasing the demand for renovation (merging projects), large construction companies may be attracted, for which individual projects are not financially attractive. Secondly, the combination of individual projects (in particular within the same geographical area, such as block renovation) exploits economies of scale, reduces operating costs and is likely to reduce the cost of construction. Thirdly, the merging of projects offers opportunities to attract major financial institutions that can offer better financing conditions. Fourth, the merging of projects may encourage the search for innovative technological solutions.

The implementation of the block renovation (Measure P10) and the one-stop shop (Measure P18) should also contribute to the consolidation of projects.

The problem to be solved	B6. Renovation becoming more expensive B7. Full potential of renovation benefits not realised B12. Reluctance of financial institutions to lend (limited lending possibilities)
Proposed measure	Implementing partial renovation
Priority	High
Implementation perspective	Medium-term

P14. Ensuring sustainability and innovation

The European Green Deal stipulates that sustainability must be mainstreamed into all EU policies, including building construction and renovation. For example, the European Commission is committed to revising the Construction Products Regulation[56], which should ensure that the design of new and renovated buildings meets the needs of the circular economy at all stages and encourages greater digitisation of the building economy and its resilience to climate change. The renovation itself must also be carried out in an energy and resource-efficient manner.

Accordingly, the renovation strategy should aim at:

- establishing minimum requirements for the renovation process and the materials used;
- promoting the use of new products and process innovations, for example through additional funding.

Another important element of the renovation is the emergence of new innovations, in particular the industrialisation of construction, and prefabricated construction. It is the pre-production of walls and roof structures, which reduces construction work on the building site to a few days. Such production also increases the quality and reduces the volume of waste.

It is important to make use of good practice in projects in the EU and other countries. The EU is developing this area by funding pilot projects, the model of which will be made available to EU Member States. Examples of such projects are: DRIVE0 and MORE-CONNECT, during which prefabricated structures have already been renovated in apartment buildings in Estonia and Latvia.

It is important to note that the implementation of sustainability and innovation solutions from the declaration of the goal to the practical implementation takes a long time, so it is important to start the necessary steps as early as possible.

[56] Regulation (EU) No 305/2011 of the European Parliament and of the Council of 9 March 2011 laying down harmonised conditions for the marketing of construction products and repealing Council Directive 89/106/EEC

The problem to be solved	B6. Renovation becoming more expensive B8. Sustainability of the transformation is not ensured B19. Restrictions on the workforce in the construction sector
Proposed measure	Mainstreaming sustainability in planned measures, promoting innovation
Priority	Medium
Implementation perspective	Medium- to long-term period
Good practices	[DRIVE0 Project]

P15. Management of minimum requirements

to maximise the benefits of renovation, minimum requirements should be established and proactively managed for the reconstruction of buildings at each typical moment of the reconstruction initiation (see Chapter 2.9 for details), e.g.:

- the bar for minimum energy performance requirements for publicly funded renovation projects is continuously raised;
- a list of mandatory renovation works and technical solutions for public funding is established, e.g.: adaptation of housing/environment for the disabled, installation of charging stations for electric cars, provision of ventilation with thermal insulation, etc;
- setting requirements for selected types of commercial building transactions e.g. minimum energy performance requirements for rental buildings;
- raising the bar for minimum energy performance requirements for building refurbishment, etc.

It is important to ensure that the management of minimum requirements is planned and predictable, i.e. requirements are set and published in advance, providing for a transitional period, thus allowing building owners to adapt to requirements on a voluntary basis (using support measures).

The problem to be solved	B7. Full potential of renovation benefits not realised
Proposed measure	Management of minimum requirements
Priority	High
Implementation perspective	Short- to medium-term period

6.2.3. Adequate financing

The intended breakthrough in renovation will require significantly higher investment. Due to the low energy prices and, consequently, the long payback period of the investments, it is expected that not all investments will be financed by the building owners alone, i.e. renovation will require a public incentive (subsidies).

In addition, even with appropriate financial incentives and other support measures, significant investments will be required from building owners, the lack of which may lead to a refusal to renovate. Accordingly, attractive financing solutions must exist to finance the owner’s contribution/investment.

Failure to secure sources of funds for the part financed by the State and financing decisions for the part of the investment by the building owner, while other conditions (e.g. energy prices) remain unchanged, may make the lack of financing a critical barrier to the implementation of renovation.

P16. Ensuring funding

According to preliminary estimates, to meet the LTRS milestones, the renovation of the building stock will require an average investment of EUR 1.1 billion per year up to 2030; the investment needs will grow to up to EUR 3.1 billion a year in subsequent periods, in line with the growing need for subsidies and building owners’ investment financing. Accordingly, the provision of funding must address these main issues:

- **Securing of funds for the state-funded share (subsidies).** Existing sources will become scarce by 2030; therefore, new sources need to be explored, in particular to benefit from the European Union funds (e.g. through the inclusion of renovations in the 2021–2027 programmes), and planned initiatives (e.g. the European Green Deal Investment Plan).
- **Development of investment financing solutions for building owners**. The predicted significant increase in the owner's investment financing needs is unlikely to be satisfied by the existing financing solutions. Accordingly, the ability to create and offer to the market financial measures with a high leverage effect[57] and involving private funds, pension funds and international financial institutions is of great importance for ensuring financing.

It should be noted that the multi-apartment renovation financing model currently used in Lithuania (subsidies, preferential loans and interest fixing) is recognised as a good practice in Europe and could be transferred to other parts of the building stock. However, additional mechanisms based on the involvement of the private sector should be considered when assessing the extent of the increase in financing needs., the energy saving company (ESCO) model, the implementation and development of which is also promoted by the EU directives[58].

According to the assessment of the EC Joint Research Centre in 2019[59], in Lithuania the ESCO market is one of the least developed among all EU Member States, not only does not have an official list of ESCO companies, but also clear common criteria according to which companies could be classified as ESCO type. Most companies interested in providing energy-saving services are financially incapable, there are no success stories of ESCO projects ", commercial banks are not ready to finance projects under the current conditions, the legal framework is not fully established, etc. In addition, the recent decline in average heat prices prolongs the payback periods and financial viability of projects.

In March 2020, the financing conditions provided by the VIPA for the renovation projects of state-owned buildings were significantly improved. Projects using the ESCO model receive funding in the form of a repayable grant of up to 80% and a loan of up to 20% of the investment.

It is important to note that both the financing needs and the specific financing solutions must be coordinated and planned together with other renovation measures, such as:

- full energy price and pollution taxes would shorten the payback period of investments (increase the financial attractiveness of renovation), which would reduce the need for public funds (subsidies). A shorter payback period for investments would also increase the choice of financing solutions (e.g. the ESCO model would become more economically viable);
- the aggregation of projects would make it possible to exploit the effect of economies of scale (reduce the need for investments), which would reduce the need for both public funds (subsidies) and owners' investments.

The problem to be solved	B10. Inability of building owners to borrow (limited borrowing possibilities) B11. Increased need for public finances
Proposed measure	Implementation of funding instruments
Priority	High
Implementation perspective	Medium-term

6.2.4. Effective communication

[57] Instruments with a 1:5 leverage effect are currently being developed in the renovation of multi-apartment buildings, i.e. aiming to leverage 5 euro from the private sector or other third parties for every euro of public finance.
[58] Article 18 of the Amending Directive obliges Member States to develop a legislative and information environment enabling the ESCO model and to improve the entry of small and medium-sized enterprises into this market.
[59] Joint Research Centre (JRC) Science for Policy Report on the Energy Service Market in the EU (2019): http://publications.jrc.ec.europa.eu/repository/bitstream/JRC118815/jrc118815.pdf

Communication is one of the key elements of renovation. Even after the measures described above have been implemented, building owners are likely not to take a decision to renovate their housing if they do not have information on the renovation costs and existing support measures. Clear, seamless, coordinated, and timely communication is needed to keep building owners informed, as beneficiaries.

The importance of communication is also increased by the IRS' planned renovation surge (a significant increase in the volume of renovation projects) covering the entire building stock. In the result, in terms of communication, the target audience expands from several specific segments (multi-apartment residents and public building managers) to virtually all homeowners in Lithuania.

In the analysis of communication barriers (see Chapter 4.1.4), two essential communication barriers were identified:

- insufficient communication on the inevitability of renovation;
- Insufficient communication on the benefits of renovation.

P17. Communicating the indicators and inevitability of renovation

For the part of the low energy efficiency building stock, in the long term, there is basically no choice to participate in renovation. The essential factors that make renovation inevitable:

- the poor technical condition of most buildings (by 2050, some of them will have to be renovated anyway, with or without public support);
- Lithuania, as an EU country, must comply with the provisions of EU strategic documents (regulations, the Green Deal, etc.). fulfilling EU obligations is part of being in the EU;
- accordingly, disciplinary measures (pollution taxes, restrictions on the rent/sale of inefficient buildings, etc.) intended to manage irresponsible and irrational behaviour of building owners will inevitably appear alongside incentives to participate in renovation.

Communication on the inevitability of renovation should focus on two segments:

- building owners (motivating them to participate);
- representatives of construction, design, financing and other stakeholders involved in renovation (providing assurance that public policy on this issue is clear, binding and long-term).

This would convey the message that the State is committed to achieving the targets set out in the LTRS, providing the necessary support for this purpose, but at the same time providing for disciplinary measures for failure to comply with the prescribed direction.

The problem to be solved	B14. Insufficient information on the inevitability of renovation
Proposed measure	Development of the LTRS communication strategy
Priority	High
Implementation perspective	Short- to long-term period

P18. Communication on the benefits and measures of renovation

The owner's investment is financial, while the benefits of renovation are multifaceted (not only energy cos savings, but also increase in housing value, improved social environment, improved health, building security, etc.). Accordingly, for a building owner to believe in the benefits of renovation, he must be made aware of the full range of opportunities and benefits of renovation. This is particularly the case where, due to the inclusion of incomplete costs, the price of energy is low and, as a result, the financial benefits of renovation do not constitute a sufficient motivation to participate in renovation.

In our assessment, communication could be organised on two levels:

- at national level and through dedicated communication channels, the information is relevant for the entire target audience (e.g. success stories, and benefits of renovation, etc.);

- at the municipal level and through the dedicated communication channels, the information is relevant to the target audience of that municipality, considering the specificity of the building stock, the needs and opportunities of households, etc.

The problem to be solved	B13. Insufficient information on the benefits of renovation
Proposed measure	Development of the LTRS communication strategy
Priority	High
Implementation perspective	Short- to long-term period

6.2.5. Reliable implementation system

to attract building owners and to ensure the achievement of renovation indicators, a reliable renovation implementation system ensuring a smooth process is necessary. Even if the building owner believes in the benefits of the renovation and has attractive financing options, they may decide against the renovation if they face administrative obstacles planning and/or in the implementation and implementation stage, e.g. as the process will require significant time investments or competencies that they do not have, or if they do not have the necessary confidence in the existing system and its result. To ensure a smooth process and to take into account the needs of building owners, it is necessary to approach building owners both physically and in response to their needs.

P19. Implementation of the one-stop shop

The lack of information on the benefits, measures and fragmentation of the LTRS (different, uncoordinated sources) is one of the barriers to the implementation of renovation. The EPBD and the Recommendation, respectively, encourage the states to apply 'accessible and transparent advisory tools, such as one-stop shops for consumers and energy advisory services'.

A one-stop shop should ensure that the owner of a building learns about the costs of renovation and all possible measures in one place and is able to arrange all documents (both technical and financial) in one place when he decides to implement it.

The best preconditions for the implementation of one-stop shop functions are the municipalities which have the most reliable data on buildings and the building owners within the area are in constant contact with the municipality on other issues. Also, municipalities are best placed to coordinate the implementation of the block renovation (Measure P10). Accordingly, the establishment of a separate entity within the municipal scope which would be responsible for the servicing of building owners on renovation issues should be considered, with methodological and advisory assistance from the competence centre (Measure P19).

It is important to note that the interests of the owners of different groups of buildings differ (e.g. individual houses, multi-apartment buildings, industrial buildings and other non-residential buildings). Their service could be broken down accordingly. In other words, it is important for a building owner to be able to get all the services in one place, but different boxes may be created for different owners.

The problem to be solved	B13. Insufficient information on the benefits of renovation
Proposed measure	Implementation of the one-stop shop
Priority	High
Implementation perspective	Medium-term
Good practices	One-stop-shops for energy renovations of buildings (2018) A guide for the launch of a One Stop Shop on energy retrofitting (2017)

P20. Establishment of a competence centre

to achieve a renovation breakthrough, it is important to ensure the smoothness of the renovation process. Together with the implementation of the one-stop shop, the centralisation of competences in one place – the competence centre – would contribute significantly to this.

It is the responsibility of the competence centre to:

- development of standardised documents/procedures;
- drafting rules and technical requirements;
- aid to municipalities;
- consultancy.

Within the scope of the Programme for the modernisation of multi-apartment buildings a similar role is played by BETA, which provides advice and assistance to homeowners in the modernisation of multi-apartment buildings and publishes advisory material. A centre of excellence covering all parts of the renovation strategy could also be created on its basis or as an example.

The problem to be solved	B15. Insufficient managerial capacity of municipalities B16. Barriers to the procurement process B17. Poor quality investment plans
Proposed measure	Establishment of a competence centre
Priority	High
Implementation perspective	Medium-term
Good practices	Information publication 'Maintenance of retrofitted multi-apartment buildings and construction quality assurance' (BETA)

P21. Quality assurance

Inadequate quality control (technical supervision) of the planning and implementation of renovation projects is one of the disturbances of renovation, increasing the confidence of building owners in the entire renovation process and causing renovation delays.

Currently, the project administrator is responsible for the preparation of the renovation investment plans and the control of their implementation, the work of which is supervised by the BETA. However, according to the data of the public audit report, there are frequent cases where the administrators do not properly perform the duties of the builder (client)[60].

Accordingly, to ensure that investment plans for the modernisation of multi-apartment buildings are drawn up in a high-quality manner and that work is carried out without defects and in accordance with the investment plan, measures should be envisaged to increase the competence of project administrators in the performance of their functions or by providing for additional external controls: the appointment of technical supervisors, on-site inspections, etc. The establishment of a Competence Centre (measure P19) should contribute to the implementation of this measure by providing both advisory assistance and the preparation of standard documents and instructions for their completion.

The problem to be solved	B17. Poor quality investment plans B18. Insufficient quality control of renovation implementation
Proposed measure	Concentration of maintenance responsibilities
Priority	High
Implementation perspective	Medium-term

6.3. PRIORITY AXES FOR IMPLEMENTING THE STRATEGY

The LTRS covers a long period of time (30 years) during which it will be reviewed on several occasions and revised as necessary (see Chapter 6.4). To implement the LTRS in a systematic, coherent and sustainable way, it is

[60] Public Audit Report on the Renovation (Modernisation) of Multi-apartment Buildings, the National Audit Office of Lithuania

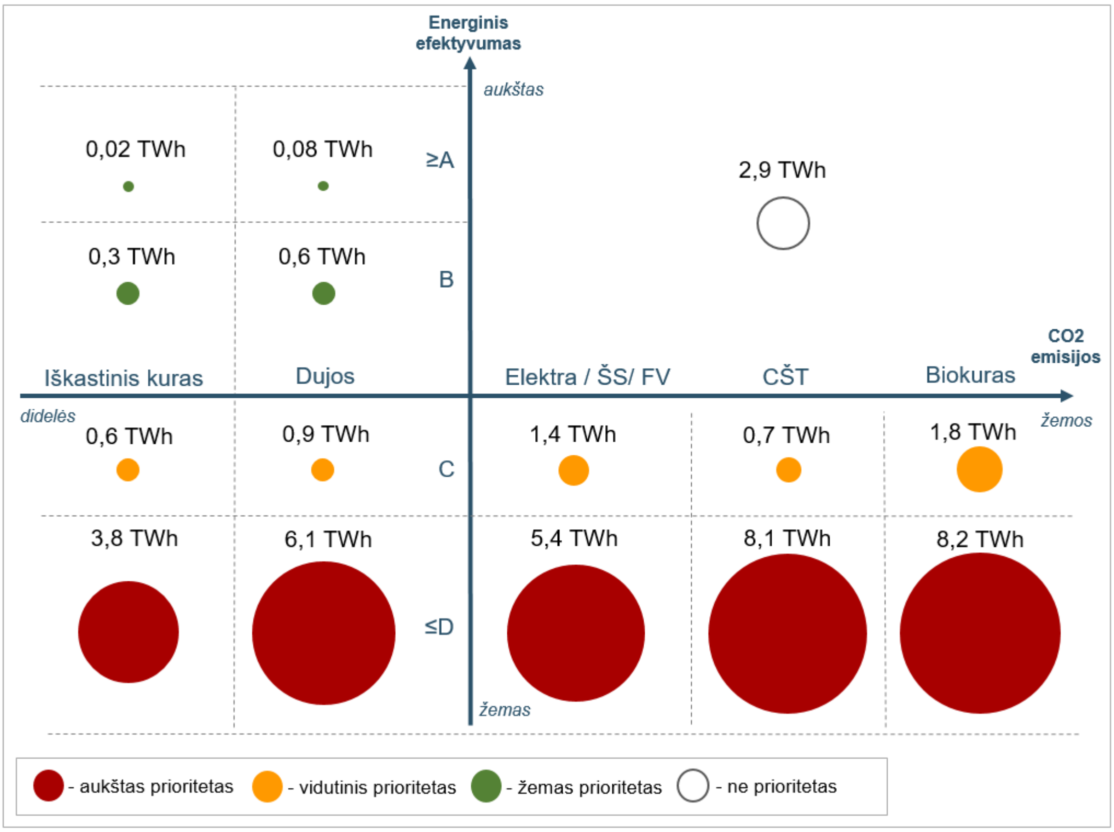
important to identify the priority segments of the building stock, to thoughtfully plan the measures necessary for their transformation and to allocate the resources needed for their implementation.

Both the LTRS indicators and the renovation measures used to achieve them can be divided into two main groups:

- improving energy efficiency;
- increasing the use of RES (reduction of fossil fuels).

To identify priority groups of buildings, the building stock may be divided accordingly. The figure below shows the primary energy consumption of the building stock by energy efficiency (from the worst to the best) and by thermal energy source (from the highest to the lowest CO_2 emissions per unit of energy produced).

Figure 29. Primary energy consumption by energy efficiency and heat source (GWh/year)



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

Summarising the data presented in the figure above, it is possible to identify the priority groups of the building stock.

High priority:

- low energy efficiency buildings (EPC ≤ D) using fossil fuels (9.9 TWh), which are subject to both EE and RES measures;
- low energy efficiency buildings not using fossil fuels[61] (21.7 TWh), which are subject to EE measures.

Medium priority:

- medium energy efficiency buildings (EPC C) using fossil fuels (1.5 TWh), which are subject to both EE and RES measures;
- medium energy efficiency buildings (3.9 TWh) not using fossil fuels, which are subject to EE measures.

Low priority:

[61] The LTRS scope estimates that the electricity and DH sectors will evolve towards fossil fuel divestment (based on the NEIS)

- high energy efficiency buildings (EPC ≥ B) using fossil fuels (1 TWh), which are subject to both EE and RES measures.

The priority axes identified above should be reflected in the package of measures being prepared, providing for support measures targeted at the priority segments of the building stock, e.g. district renovation for low-energy multi-apartment buildings, RES measures to replace individual sources of production using fossil fuels, etc.

The implementation of specific RES measures may be carried out by choosing various RES sources, such as the installation of heat pumps and/or photovoltaic solar collectors, the production of electricity from wind or hydroelectric power plants, the production of biofuels, the production of heat from water-heating solar collectors, connection to DH grids, the purchase and consumption of energy from remote solar, wind and hydroelectric power plants.

It is estimated that the DH and electricity sectors will transform purposefully in the direction of fossil fuel abandonment during the implementation of the LTRS, therefore replacing them with alternative RES measures would not be economically rational and would not be encouraged. This provision should be reassessed periodically (by updating the LTRS), considering the actual results of the envisaged sectoral transformation.

The LTRS's priority axes described above comply with the provisions of the EPBD and other EU strategic documents providing that:

- in the renovation of the building stock, priority is given to 'efficient energy use, applying the Energy Efficiency First principle, and considering the use of RES';
- great attention must be paid to buildings with the lowest energy performance;
- financial measures to improve energy efficiency in the renovation of buildings should be linked to the target or achieved energy savings.

Financial measures to improve energy efficiency in the renovation of buildings should be linked to the target or achieved energy savings.

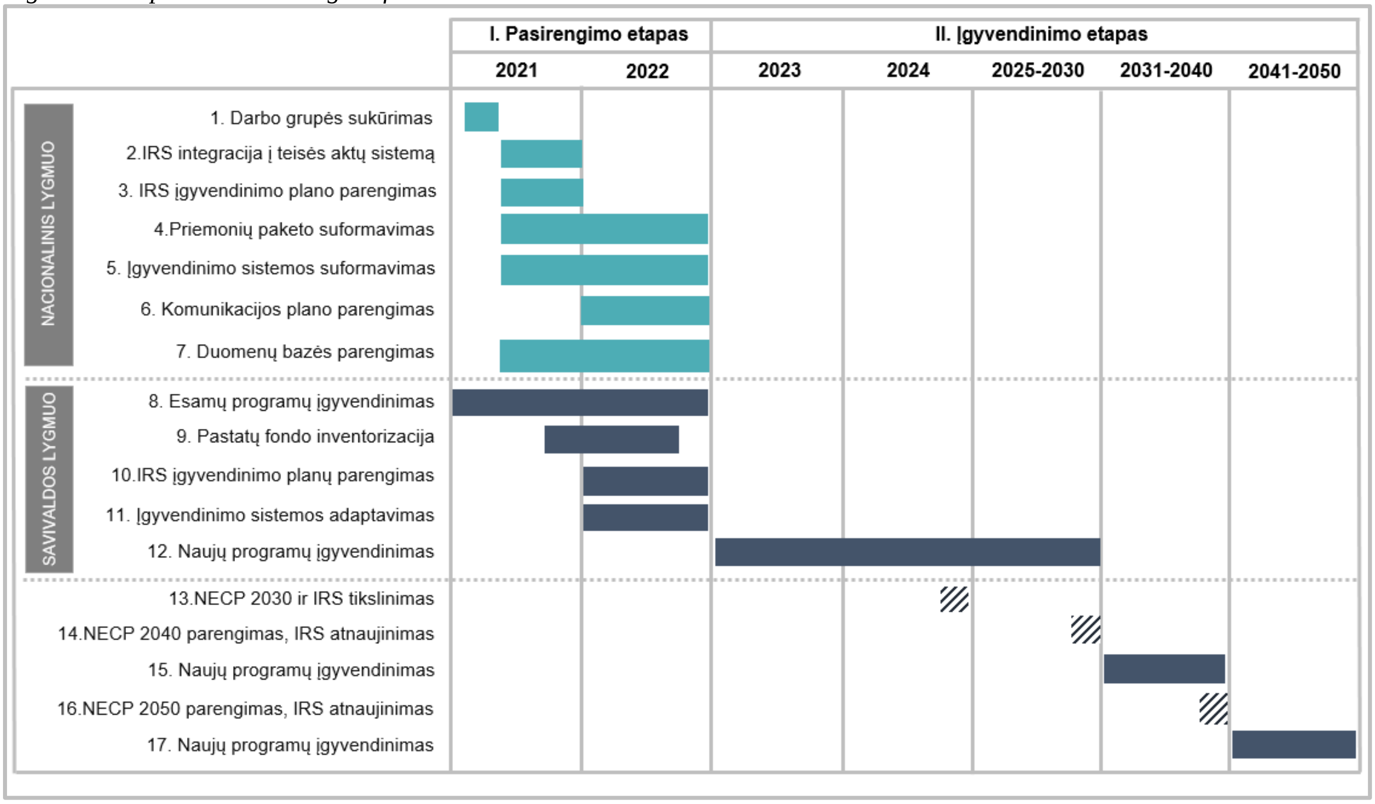
6.4. IMPLEMENTATION STAGES OF THE STRATEGY

The period of implementation of the LTRS from 2021 to 2050 is divided into two main stages:

- I. Preparatory stage (2021–2022).
- II. Implementation stage (2023–2050).

During the implementation of the LTRS, it is planned that the LTRS will be updated twice in principle (when drafting NECP 2040 and NECP 2050), and revised three times (when updating NECP 2030, NECP 2040, and NECP 2050, in the mid-implementation period).

Figure 30. Implementation stages of the LTRS



Source: The authors of the study to develop the long-term renovation strategy of Lithuania

A description of the main steps in the implementation of the LTRS is provided below.

1. Creation of a working group (Measure P1)

The establishment of an organisational structure responsible for the implementation of the LTRS, such as an interinstitutional working group (committee) (the 'project manager'), is a first step towards the implementation of project management principles in line with good practice in the LTRS.

The project manager would implement the functions of the LTRS project manager, i.e. within the limits of its mandate, would be responsible for the identification, review and updating of LTRS indicators, the compatibility of the LTRS with other energy efficiency and RES promotion policy measures, energy sector planning, etc. The composition of the working group should take into account both good design management practices and the needs of the main stakeholders (e.g. the Ministry of the Environment of the Republic of Lithuania, the Ministry of Energy of the Republic of Lithuania, the Ministry of Finance of the Republic of Lithuania, the Ministry of the Interior of the Republic of Lithuania, the Ministry of Social Security and Labour of the Republic of Lithuania, and the Lithuanian Association of Local Authorities, etc.), and their role in the IRS implementation process.

2. Integration of the LTRS into the legislative framework (Measure P3)

The implementation process of the LTRS is highly fragmented, with many involved parties with different interests, acting in accordance with different legislation, financing their contribution to the implementation of the LTRS from different sources of funding, etc. Accordingly, to avoid legislative obstacles to the implementation of the LTRS, the project manager should initiate the integration of the LTRS into the legislative framework, including:

- **Vertical integration upwards**: integration into strategy papers at a higher level (e.g. the NECP and the National Progress Programme).
- **Horizontal integration**: updating strategic legislation in the sectors concerned, integrating the indicators set by the LTRS and/or the impact of their implementation (e.g. strategies in the energy sector should be aligned with the reduction of energy consumption planned in the LTRS).
- **Vertical integration downwards**: integration into legislation at a lower level, such as:

- **Formalisation of the model of the role and responsibilities of local self-government** by choosing the format of the obligation (e.g. by providing for new obligations in the Law of the Republic of Lithuania on Local Self-Government) or the agreement (e.g. by signing agreements with each municipality), as well as by establishing obligations related to the implementation of the LTRS, e.g. to collect data on the municipal building stock (see Stage 9), to draw up municipal LTRS implementation plans (see Stage 10), and to implement the one-stop-shop principle (see Stage 11), etc.
- **Adoption stricter minimum requirements for the energy performance class (energy consumption) of buildings** under renovation to avoid the need for renovation of buildings renovated to energy performance class C under the existing renovation programmes.

3. Development of the LTRS implementation plan

In accordance with the strategic planning practices and requirements, long-term LTRS indicators and priorities are elaborated in a short- to medium-term planning document (e.g. the LTRS implementation plan or the interinstitutional operational plan for the implementation of the LTRS), covering all the institutions concerned and setting out the indicators, tasks, measures (see Stage 4) and appropriations for the implementation of the LTRS for the period 2021–2030[62].

4. Development of a package of measures (Measures P6–P15)

A package of support measures corresponding to the targeted LTRS indicators. The package of support measures should ensure:

- proper implementation of the LTRS priority axes (see Chapter 6.3 for details);
- the application of balanced complex motivational measures (both incentives and penalties) and maximisation of the pace and benefits of renovation (see Chapter 6.2.2 for details);
- the adequacy and availability of funding sources and mechanisms (see Chapter 6.2.3 for details);
- setting minimum requirements for energy performance (energy consumption) after renovation.

The aim should be for the implementation of the new package of support measures to start and completely replace the existing measures from 2023.

5. Development of the implementation framework (Measures P19–P21)

to ensure the smooth implementation of the renovation process and to enable the achievement of a quality renovation result, the project manager should develop the implementation framework of the LTRS. Key elements of the system should include:

- a **competence centre** providing technical and methodological assistance to the municipalities implementing the one-stop shop (see Stage 11);
- a **quality control mechanism** covering all stages of the renovation implementation, from investment and energy savings planning (e.g. development of investment plans) to quality assurance of the renovation work (e.g. maintenance and/or work quality insurance);
- a **monitoring system** that collects information on the results of the renovation and ensures the monitoring of the LTRS indicators. The basis for the monitoring system should be the developed database of the building stock (see Stage 7). The system should be integrated with the NECP indicator monitoring system.

The authority(ies) responsible for the implementation of these elements should be designated, ensuring adequate funding.

6. Development of the communication plan (Measures P16-P18)

[62] Pending preparation of NECP 2040 and update of the LTRS (see Stage 14)

The project manager should develop an LTRS communication strategy covering both long-term renovation rates and specific renovation measures. The authority responsible for implementing the communication should be designated. The principles of communication are described in more detail in Chapter 6.2.4.

7. Development of the database vehicles (Measure P2)

to address the data gap, the building stock database should be developed. The principles of development of the database are described in more detail in Chapter 6.3.1. The database should be built in the following stages:

- requirements for data collection in municipalities are established: data structure, data collection methodology, format (method) and deadlines;
- parallel data collection in municipalities (see Stage 9) develops a methodology for data processing and comparison with external sources, e.g. energy consumption data of the building stock must be compared with energy and fuel balance data (actual consumption), as this source relies on the monitoring of NECP implementation;
- the data collected in the municipalities are consolidated by filling in the database and updating the LTRS indicators (see Stage 13).
- a process for collecting data on the renovation carried out shall be established, during which the existing data of the building stock shall be supplemented. This would form the basis for the proper functioning of the monitoring system (see Stage 5).

It is important to appoint a long-term administrator of such a database and to ensure its source of funding and to grant the administrator the necessary data access rights and powers (e.g. the power to collect certain data from energy suppliers).

8. Implementation of existing programmes

The implementation of the existing support programmes must be ensured during the preparatory stage. Once the package of new support measures has been developed (see Stage 4), the implementation stage of the LTRS, and the implementation of the new support measures starts (see Stage 12).

9. Inventory of building stock (Measure P2)

based on the developed data collection instructions and the required data structure (see Stage 7), municipalities should collect information on the existing building stock: the number and area of buildings used (heated), their energy production sources and energy consumption. The information collected should be made available in a centralised database and used for the development of IRS implementation plans in municipalities (see Stage 10).

10. Development of the LTRS implementation plans

based on the indicators established by the LTRS and the information collected on the municipal building stock (see Stage 9), municipalities must prepare municipal LTRS implementation plans that include:

- **the planned indicators**. The actual energy consumption of the municipal building stock is reported and LTRS indicators (number of buildings to be renovated, reduction in energy consumption, etc.) are established;
- **integration with other planning documents**. Plans should be aligned (or merged) with other municipal planning documents, including but not limited to: RES energy development action plans, heating sector specific plans, spatial planning documents, etc.

11. Adapting the implementation framework (Measure P5)

Municipalities should adapt the support measures (see Stage 4) and the national implementation framework for the LTRS (see Stage 5) at local level, ensuring the implementation of the one-stop shop. A mechanism should be put in place to ensure that the building owner can:

- find out all the information about renovation money and all available support measures in one place;

- once they have decided to carry out the renovation, they can organise all the paperwork (both technical and financial).

12. Implementation of the new programme package

Once the package of new support measures has been developed (see Stage 4), the implementation stage of the LTRS, and the implementation of the new support measures starts.

13. Update of the NECP and the LTRS

The LTRS is an integrated part of the NECP in implementing the requirements of the EU Directives. considering the requirements of the NECP, the LTRS must be updated and submitted to the European Commission together with the updated NECP by June 2024. During the LTRS update, there should be:

- the revised targets of the LTRS (based on a functioning database (see Stage 4);
- revised descriptions of ongoing LTRS measures (based on the new package of support measures (see Stage 8).

14. Preparation of the NECP 2040 and update of the LTRS

The LTRS is an integrated part of the NECP in implementing the requirements of the EU Directives. considering the requirements of the NECP, the NECP for the new period (2031–2040) should be drawn up and submitted to the European Commission by 1 January 2029. Accordingly, during the LTRS update, there should be:

- revision of the targets set by the LTRS, considering the energy consumption and CO_2 emission reduction targets planned by the NECP for the new period, based on actual information on the implementation of the LTRS;
- a new package of support measures has been formed.

15. Implementation of new programmes

Once the package of new support measures has been developed (see Stage 14), the implementation stage of the LTRS, and the implementation of the new support measures continues.

Similarly to Stages 14–15, Stage 16 ‘Preparation of the NECP 2050 and update of the LTRS’, and Stage 17 ‘Implementation of new programmes’ are being implemented.

ANNEX 1. PACES OF RENOVATION OF OTHER NON-RESIDENTIAL BUILDINGS

The tables below summarise the planned rates of renovation of Other non-residential buildings.

Annual paces of renovation of other non-residential buildings

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	units/year	518	719	1 147	1 373
Other non-residential buildings	thousand m^2/year	413	573	914	1 094

Total paces of renovation of other non-residential buildings during the period

Building benchmark	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	units/year	1 554	5 035	11 467	13 730
Other non-residential buildings	thousand m^2/year	1 239	4 013	9 139	10 942

The tables below provide information on the possible detailed pace of the benchmark renovation of other non-residential buildings by building use and the ownership type. Specific planned indicators may differ by building use if the aggregated planned indicators are maintained.

Average number of other non-residential buildings under renovation per year

Building use	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Administrative facilities	Public	units/year	29	40	63	76
Administrative facilities	Private	units/year	106	148	235	282
Catering facilities	Public	units/year	3	4	7	8
Catering facilities	Private	units/year	18	26	41	49
Service facilities	Public	units/year	5	7	11	13
Service facilities	Private	units/year	36	50	80	95
Trading facilities	Public	units/year	2	3	4	5
Trading facilities	Private	units/year	105	146	233	279
Hotels	Public	units/year	–	–	1	1
Hotels	Private	units/year	7	9	15	18
Health care facilities	Public	units/year	11	15	24	29
Health care facilities	Private	units/year	11	16	25	30
Cultural facilities	Public	units/year	17	24	38	46
Cultural facilities	Private	units/year	13	17	28	33
Educational facilities	Public	units/year	44	61	97	116
Educational facilities	Private	units/year	16	23	36	43
Transport facilities	Public	units/year	4	5	8	10
Transport facilities	Private	units/year	3	4	7	9
Recreation facilities	Public	units/year	5	7	11	13
Recreation facilities	Private	units/year	65	90	143	172
Sports facilities	Public	units/year	3	5	7	9
Sports facilities	Private	units/year	3	4	6	8
Special-purpose buildings	Public	units/year	8	11	18	21
Special-purpose buildings	Private	units/year	4	5	9	10
Total		**units/year**	**518**	**719**	**1 147**	**1 373**

Average area of other non-residential buildings under renovation per year

Building use	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Administrative facilities	Public	thousand m^2/year	25	34	55	65
Administrative facilities	Private	thousand m^2/year	95	132	211	252
Catering facilities	Public	thousand m^2/year	2	3	5	6
Catering facilities	Private	thousand m^2/year	8	11	17	21
Service facilities	Public	thousand m^2/year	1	2	3	4
Service facilities	Private	thousand m^2/year	14	19	31	37
Trading facilities	Public	thousand m^2/year	1	2	3	3
Trading facilities	Private	thousand m^2/year	61	85	136	163
Hotels	Public	thousand m^2/year	0	0	1	1
Hotels	Private	thousand m^2/year	8	12	19	22
Health care facilities	Public	thousand m^2/year	22	30	48	58
Health care facilities	Private	thousand m^2/year	10	14	22	27
Cultural facilities	Public	thousand m^2/year	19	26	42	50
Cultural facilities	Private	thousand m^2/year	10	14	22	26
Educational facilities	Public	thousand m^2/year	85	117	187	224
Educational facilities	Private	thousand m^2/year	19	26	41	49
Transport facilities	Public	thousand m^2/year	1	2	3	3
Transport facilities	Private	thousand m^2/year	1	2	3	4
Recreation facilities	Public	thousand m^2/year	2	2	4	5
Recreation facilities	Private	thousand m^2/year	14	19	31	37
Sports facilities	Public	thousand m^2/year	4	6	9	11
Sports facilities	Private	thousand m^2/year	3	4	7	9
Special-purpose buildings	Public	thousand m^2/year	5	7	11	13
Special-purpose buildings	Private	thousand m^2/year	2	2	3	4
Total		**thousand m^2/year**	**413**	**573**	**914**	**1 094**

Total number of other non-residential buildings under renovation during the period

Building use	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Administrative facilities	Public	units	364	634	759	1 758
Administrative facilities	Private	units	1 352	2 353	2 817	6 523
Catering facilities	Public	units	40	69	83	192
Catering facilities	Private	units	234	407	487	1 128
Service facilities	Public	units	60	105	126	292
Service facilities	Private	units	457	796	953	2 206
Trading facilities	Public	units	24	41	50	115
Trading facilities	Private	units	1 337	2 327	2 787	6 451
Hotels	Public	units	4	7	9	20
Hotels	Private	units	85	149	178	412
Health care facilities	Public	units	140	244	292	676
Health care facilities	Private	units	143	249	298	689
Cultural facilities	Public	units	220	382	458	1 060
Cultural facilities	Private	units	159	277	331	767
Educational facilities	Public	units	557	969	1 160	2 685
Educational facilities	Private	units	207	361	432	1 000
Transport facilities	Public	units	48	84	101	233
Transport facilities	Private	units	41	71	85	198
Recreation facilities	Public	units	61	107	128	297
Recreation facilities	Private	units	824	1 434	1 718	3 976
Sports facilities	Public	units	43	74	89	206
Sports facilities	Private	units	36	63	76	175
Special-purpose buildings	Public	units	101	176	211	489
Special-purpose buildings	Private	units	50	86	104	240
Total		units	6 589	11 467	13 730	**31 787**

Total area of other non-residential buildings under renovation during the period

Building use	**Ownership**	**Unit of measure**	**2021–2023**	**2024–2030**	**2031–2040**	**2041–2050**
Administrative facilities	Public	thousand m^2	314	547	654	1,515
Administrative facilities	Private	thousand m^2	1,211	2 108	2 524	5 843
Catering facilities	Public	thousand m^2	30	53	63	146
Catering facilities	Private	thousand m^2	98	171	205	475
Service facilities	Public	thousand m^2	18	31	37	87
Service facilities	Private	thousand m^2	177	309	370	856
Trading facilities	Public	thousand m^2	16	27	32	75
Trading facilities	Private	thousand m^2	782	1361	1629	3,772
Hotels	Public	thousand m^2	4	8	9	21
Hotels	Private	thousand m^2	108	188	225	520
Health care facilities	Public	thousand m^2	278	484	580	1,343
Health care facilities	Private	thousand m^2	128	222	266	616
Cultural facilities	Public	thousand m^2	241	419	502	1 161
Cultural facilities	Private	thousand m^2	124	216	258	598
Educational facilities	Public	thousand m^2	1 075	1 870	2 239	5 184
Educational facilities	Private	thousand m^2	236	410	491	1 137
Transport facilities	Public	thousand m^2	15	27	32	74
Transport facilities	Private	thousand m^2	19	33	39	91
Recreation facilities	Public	thousand m^2	22	38	45	105
Recreation facilities	Private	thousand m^2	177	308	369	855
Sports facilities	Public	thousand m^2	54	94	112	260
Sports facilities	Private	thousand m^2	41	72	86	198
Special-purpose buildings	Public	thousand m^2	63	110	131	304
Special-purpose buildings	Private	thousand m^2	20	35	42	97
Total		**thousand m^2**	**5 251**	**9 139**	**10 942**	**25 332**

ANNEX 2. PACES OF RENOVATION OF OTHER PUBLIC NON-RESIDENTIAL BUILDINGS

The tables below summarise the planned paces of renovation of other public non-residential buildings.

Paces of renovation of other public non-residential buildings per year (units)

Building benchmark	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	Municipality	units/year	36	86	178	239
Other non-residential buildings	State	units/year	94	95	111	107
Total		**units/year**	**131**	**182**	**289**	**347**

Annual rates of renovation of public property and other non-residential buildings (thousand m^2)

Building benchmark	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	Municipality	thousand m^2/year	46	110	228	307
Other non-residential buildings	State	thousand m^2/year	121	123	143	137
Total		**thousand m^2/year**	**167**	**233**	**371**	**444**

Total rates of renovation of public property and other non-residential buildings during the period (units)

Building benchmark	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	Municipality	units	109	605	1 780	2 394
Other non-residential buildings	State	units	283	666	1 114	1 071
Total		**unit**	**392**	**1 271**	**2 894**	**3 465**

Total renovation of other non-residential buildings in public ownership during the period (thousand m^2)

Building benchmark	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	Municipality	thousand m^2	139	770	2279	3067
Other non-residential buildings	State	thousand m^2	363	858	1 428	1 371
Total		**thousand m^2**	**502**	**1 628**	**3 707**	**4 438**

The table below shows the annual investments required to implement the renovation of public property buildings.

Annual investment needed to renovate other non-residential buildings in public ownership

Building benchmark	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	Municipality	EUR million/year	19	49	120	196
Other non-residential buildings	State	EUR million/year	48	55	75	88
Total		**EUR million/year**	**67**	**104**	**196**	**284**

Total investment needed to renovate other non-residential buildings in public ownership over the period

Building benchmark	Ownership	Unit of measure	2021–2023	2024–2030	2031–2040	2041–2050
Other non-residential buildings	Municipality	EUR million	56	343	1204	1960
Other non-residential buildings	State	EUR million	145	382	754	876
Total		**EUR million**	**201**	**725**	**1 958**	**2 837**

ANNEX 3. EXECUTIVE SUMMARY OF PUBLIC CONSULTATION

Article 2a(5) of the EPBD provides that to support the development of its long-term renovation strategy, each Member State shall carry out a public consultation on its long-term renovation strategy prior to submitting it to the Commission. Each Member State shall annex a summary of the results of its public consultation to its long-term renovation strategy.

Stakeholders and the public have been consulted in the preparation of the long-term renovation strategy through meetings, presentations and discussions on the strategy at events.

Public consultation was also carried out through the E. Citizen portal (*E-pilietis*) to involve citizens in decision-making (https://epilietis.lrv.lt/lt/konsultacijos/viesoji-konsultacija-del-lietuvos-ilgalaikes-renovacijos-strategijos) (https://epilietis.lrv.lt/lt/konsultacijos/viesoji-konsultacija-gauti-pasiulymus-lietuvos-ilgalaikei-renovacijos-strategijai).

On 1 October 2020, the Strategy was presented at a conference organised by the Ministry of the Environment of the Republic of Lithuania, the Lithuanian Housing Chamber, the Association of Lithuanian Housing Holding (*Lietuvos butų ūkis*), and the conference organised by Housing Energy Saving Agency, Public Institution (*Būsto energijos taupymo agentūra*) 'Perspectives of the Housing Sector. Improving energy efficiency of buildings'.

In October–November 2020, meetings were held with the Ministry of Energy of the Republic of Lithuania, the Ministry of Finance of the Republic of Lithuania, the Regional Representation of the European Investment Bank in Lithuania, Kaunas University of Technology, the Lithuanian Confederation of Renewable Resources, the Lithuanian Energy Institute, the Lithuanian Chamber of Housing, the Lithuanian Solar Energy Association, the Association of Local Authorities in Lithuania, the Lithuanian Construction Association, the Lithuanian District Heating Association, the Alliance of Lithuanian Consumer Organisations, the Association of Mineral Wool Producers, the National Association of Passive House, Public Investment Development Agency (*UAB Viešųjų investicijų plėtros agentūra*),
the BETA, the Lithuanian Energy Agency, Public Institution (*VšĮ Lietuvos energetikos agentūra*), and Vilnius Gediminas Technical University.

The table below summarises the comments and suggestions received.

Part of the Strategy	**Suggestions / Comments**
On the direction of the Strategy	Is energy efficiency an end in itself or a means to reduce CO_2?
	Does decarbonisation mean 100% RES?
On the building stock	Does the building stock really consume that much energy?
	Request for further information
	Emphasize the data gap situation and provide suggested solutions
On the rational purpose	On the investment prices
	On setting the technical indicators
On the targets	Are the goals ambitious enough?
	Is the 'run-up' period too long?
	Re-renovation of already renovated buildings (energy performance class C)
	The impact of the 'rebound effect'.
On the measures	Timeline for implementing the Strategy
	Actions in the short term
	Implementation model combining measures
On the integrated planning	Clarifying the role and integration of DH in the strategy
	More specific proposals, obligations on data inventory and compilation
	The Law on Local Self-Government of the Republic of Lithuania does not provide for a function (obligation and funding necessary for implementation)
On the comprehensive package of measures	The cost of full energy and its impact on energy poverty
	Suggestions for separate incentive mechanisms (property tax, reduced VAT, etc.)
	Suggestions for individual technical aspects that increase the benefits of renovation

	(ventilation, cooling, environment, etc.) with emphasis on mandatory solutions
	Incentive for the consumer to seek higher savings
	More emphasis on RES measures
	Demolition of buildings (as part of renovation)
On financing	Specification of funding needs (sources, components, etc.)
	ESCO as one of the sources of funding
On the implementation system	Need for system simplicity
	Establishment of a consumer guarantee mechanism
	Enhancing control of works (documentation of works, management of changes to technical solutions during construction, increasing authority and responsibility)