TALLINNA TEHNIKAÜLIKOOL

EHITUSE JA ARHITEKTUURI INSTITUUT

MAJANDUS- JA KOMMUNIKATSIOONI-MINISTEERIUM

Long-term strategy for building renovation

Tallinn
July 2020

1 Summary

The main goal of this long-term renovation strategy is the full renovation, by 2050, of buildings erected before 2000. The depth of full renovation is reflected in the minimum required energy performance of a building after a major renovation, which, according to the Estonian energy performance regulations, currently is class C[1]. The strategy has the following central principles:

- **Cost-effective application of energy efficiency requirements**
  Energy and resource efficiency; in addition to the energy performance of buildings, taking into account the environmental impact of the construction materials and processes.
- **Regional balance**
  Ensuring renovation and balanced volumes of living quarters in functional region and second-tier centres.
- **Quality of living and working environment**
  Ensuring the healthy interior climate, improving accessibility and functionality as well as abiding by the basic principles for high-quality space[2] in the solutions for buildings and public spaces during the renovation.
- **Technological development**
  The development of renovation solutions and technologies to improve the sustainability of the renovated buildings and reduce renovation costs.
- **Climate change mitigation and adaptation**
  Climate change mitigation, reduction of the carbon intensity of buildings, buildings that contribute towards climate neutrality.

The strategy is human-centred: the living and working conditions of 80% of Estonia's citizens will improve in renovated, safe and affordable buildings.

The strategy that ensures energy savings, the healthy interior climate in buildings and a high-quality spatial environment is estimated to improve the living and working conditions of 80% of Estonian citizens. The renovation of homes and workspaces as well as tearing down all derelict buildings will make the building stock safer, of better aesthetic quality, better for health, better accessible for all population groups and more affordable. For towns with a shrinking population, the strategy points to the need and opportunities for taking into account the population and infrastructure development principles in zoning and opportunities for concentrating the town centres. In urban areas where the population is getting older and smaller, it is important to not only demolish underused buildings but also to ensure full functionality of the urban space, using demolition as an opportunity to improve the availability of public services and the functions needed for the functioning of urban areas, by gathering these into synergistic spatial ecosystems.

141,000 buildings of 54 million square metres in total need renovation within 30 years.

Considering the number of existing buildings, the percentage of already renovated buildings and the projected numbers of buildings falling out of use, the number of private houses needing renovation is ~100,000, their total floor area being 14 million square metres, ~14,000 apartment buildings (18 M m^2) and ~27,000 non-residential

buildings (22 M m^2). To attain this target, it is necessary to establish, in addition to the final goal to be achieved in 30 years, the expected results and milestones of the strategy for 2030, 2040 and 2050. The introduction and large-scale launch of full renovation take time because this activity requires a learning process, qualified labour as well as the emergence of renovation-oriented enterprises and production.

The removal of market failures will encourage property owners to make investments.

As the full renovation of buildings needs large investments, it is important that as large a share of the renovation as possible be done on the initiative of building owners and be financed by them as well. The current renovation market includes the construction volumes needed for achieving this goal in all building categories except small residential buildings. However, in many cases, the renovation does not result in improved energy performance or the improvement is negligible. As to the cost-effective improvement of energy performance, the main bottlenecks that can be deemed to be the market failures the strategy will need to eliminate are:

- The buildings are renovated not to save energy but for other reasons, e.g. to improve interior climate or functionality. When renovating a building due to other reasons, the work needed for improving its energy performance might not be done.
- Property owners do not have enough financial capacity to renovate their buildings to achieve energy class C.
- When renovating, property owners often do not simultaneously think of sustainability, health and energy efficiency in a 20- to 30-year perspective, and they have a legitimate expectation to receive government support for achieving the objective the government has set.

Effective measures make renovation deeper.

To eliminate the problems, support measures and other stimulating measures are needed. The measures have to affect not the launch of the renovation but the depth of it. If a property owner launches a renovation for some reason, the measure must help them with additional work needed to achieve energy class C. When applying these measures, the majority of the investments will be made by the private sector. The baseline situation in the main building categories is as follows:

- For a private house of average size, the cost of full renovation is around €60,000, which is too big an investment for many households to make at once. Therefore, most owners of private houses renovate their property step by step. For private houses, the full renovation market has not developed yet, and renovation volumes need to grow by many times.

[1] Tallinn University of Technology. Analysis of cost-optimal minimum energy efficiency requirements for buildings. 2017

[2] Kvaliteetse ruumi aluspõhimõtted *[Basic principles for high-quality space]*: https://www.kul.ee/sites/kulminn/files/lisa_3_-_kvaliteetne_ruum_aluspohimotted.pdf

The success story of apartment building renovations awaits repetition in other building categories.

- Apartment buildings have been fully renovated in Estonia for 10 years already, allegedly with the best results compared to the rest of the EU. The financing system, the technical solutions and apartment associations' desire to renovate are there. The 50% energy savings achieved are accompanied by a healthy interior climate. Due to apartment building renovations, the energy consumption of dwellings has remained the same within the past 15 years, despite the construction of new buildings, i.e. increasing building stock. The main bottleneck has been the unstable financing of support measures.
- In the public sector, the Energy Performance of Buildings Directive includes an obligation for central governments to renovate at least 3% of buildings that have a total useful floor area of over 250 square metres and do not comply with the minimum requirements, so that these meet the minimum requirements afterwards. The renovation of municipal buildings has primarily depended on the various support measures.

The full renovation of commercial property has not started yet.

- The commercial property sector renovates on market conditions. The main work done includes smaller renovation and work that offers quick returns on the investment, but the result is by far worse than class C, and as there is no carbon taxation on final consumption, the property owners have no motivation to invest in energy performance. However, the professional competence to design and implement the required solutions is there. The market situation shows that there is a need to motivate non-residential building owners in the private sector to invest in renovations that take longer to pay off.

Financial support, loans and guarantees, the development of new technologies and know-how as well as investments into residential buildings will create a viable renovation ecosystem.

The possible renovation-related measures proposed in this strategy include financial measures (loans, guarantees and financial support), development of new technologies (prefabrication, digital tools, simple energy calculators for building owners), awareness raising (guidance materials, advice to property owners), demolition of buildings fallen out of use, additional services from the KredEx Foundation for investments into residential buildings (renovation and construction of rental buildings) and research and development activities to ensure knowledgeable and efficient action.

Starting from the current level, the renovation volumes will grow fivefold by 2035.

The strategy considers the full programme, i.e. the renovation, by 2050, of all buildings that have been built before 2000, although this might not be 100% possible in every building category. The total floor area of the buildings needing renovation is 54 million square metres. According to the strategy, the percentage of this total area to be renovated by 2030 is 22%, by 2040, 64% and by 2050, 100%. In practice, it can be assumed that around 20% of buildings in private ownership will not fully reach the renovation depth target, i.e. class C, the effect of which could be set off by renovating other buildings better in the last decade of the strategy.

Table 1. Renovation volumes proposed by the strategy until 2050, by floor area.

	Area to be renovated, m²						
	2021-2025	**2026-2030**	**2031-2035**	**2036-2040**	**2041-2045**	**2046-2050**	**TOTAL**
Private houses	400,000	950,000	1,900,000	3,100,000	3,900,000	3,800,000	14,000,000
Apartment buildings	2,280,000	3,200,000	4,000,000	3,900,000	3,000,000	1,800,000	18,000,000
Private-sector non-residential buildings	840,000	1,800,000	3,200,000	4,200,000	4,100,000	2,900,000	17,000,000
Local government buildings	680,000	1,400,000	1,300,000	480,000	70,000	0	4,000,000
Central-government buildings	200,000	240,000	230,000	150,000	70,000	20,000	900,000
	4,400,000	**7,600,000**	**10,600,000**	**11,800,000**	**11,100,000**	**8,500,000**	**53,900,000**

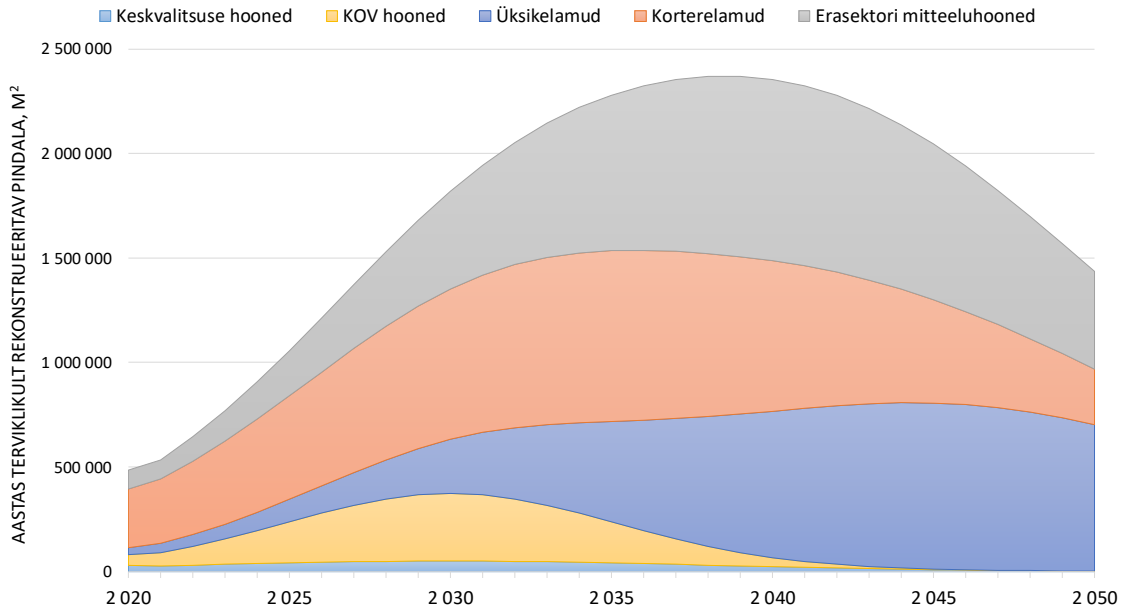


Figure 1. Cumulative annual renovation needs.

Keskvalitsuse hooned	Central-government buildings
KOV hooned	Local government buildings
Üksikelamud	Private houses
Korterelamud	Apartment buildings
Erasektori mitteeluhooned	Private-sector non-residential buildings
Aastas terviklikult rekonstrueeritav pindala, m^2	Fully renovated area per year, m^2

The renovation of apartment buildings and public sector buildings is progressing rapidly, but that of private houses and commercial property is just beginning to gain momentum.

Considering the total annual renovation volumes of various building categories, the most active renovation years will need to see the full renovation of 2.3 M square metres a year, which is almost 5 times more than currently. It is mostly achievable by adjusting the shares of new construction and renovation (see also 9.1 “Share of renovation in construction sector”).

The renovation costs of the buildings were calculated in real terms on the basis of the full renovation costs in 2019. As to public sector buildings, it turned out to be necessary to divide the average full

The average renovation price is €400 per square metre in current prices.

modernisation and conversion cost of €1100 per square metre into the cost of energy-saving renovation work (€600 per m^2) and that of other work not related to improving energy performance. As the aim of the strategy is to attain the climate goals, only the cost of the work to achieve energy savings is taken into account. Regarding other building categories, data on energy performance improvement work was gathered during the preparation of this strategy: For example, in apartment buildings, basically all work done improves energy performance. As for private-sector non-residential buildings, the strategy takes into account the renovation cost of the building envelope and building services systems, which is €600 per square metre because two-thirds of the buildings need that kind of renovation. In the remaining one-third of the buildings, modernisation of the building services systems is enough, and that would cost €200 per square metre. Thus, the average renovation cost of private-sector non-residential buildings is $0.33 \times 200 + 0.67 \times 600 = 450$ €/m^2.

So, the total cost of the full renovation of 54 million square metres, in 2019 prices, is around €22 billion, and the average full renovation cost of the buildings is €400 per square metre. If the full-renovation cost of public sector buildings is taken into account, the total cost would be €24 billion.

Table 2. Costs of the renovations proposed by the strategy until 2050.

		Renovation cost, €M						
	Cost, €/m^2	**2021-25**	**2026-30**	**2031-35**	**2036-40**	**2041-45**	**2046-50**	**TOTAL**
Private houses	400	161	381	776	1,236	1,541	1,504	5,600
Apartment buildings	300	683	953	1,189	1,160	886	530	5,400
Private-sector non-residential buildings	450	379	811	1,437	1,884	1,828	1,312	7,650
Local government buildings	600	409	869	792	287	41	2	2,400
Central-government buildings	600	119	142	136	90	41	13	540
		1,749	**3,156**	**4,330**	**4,657**	**4,337**	**3,361**	**21,590**

Annual renovation investments will reach €900 M.

The annual renovation financing needs also increase almost 5 times: from the current cost of under €200 M up to €900 M. To make building owners want to invest almost five times as much as now, the measures proposed in the strategy will need to be applied.

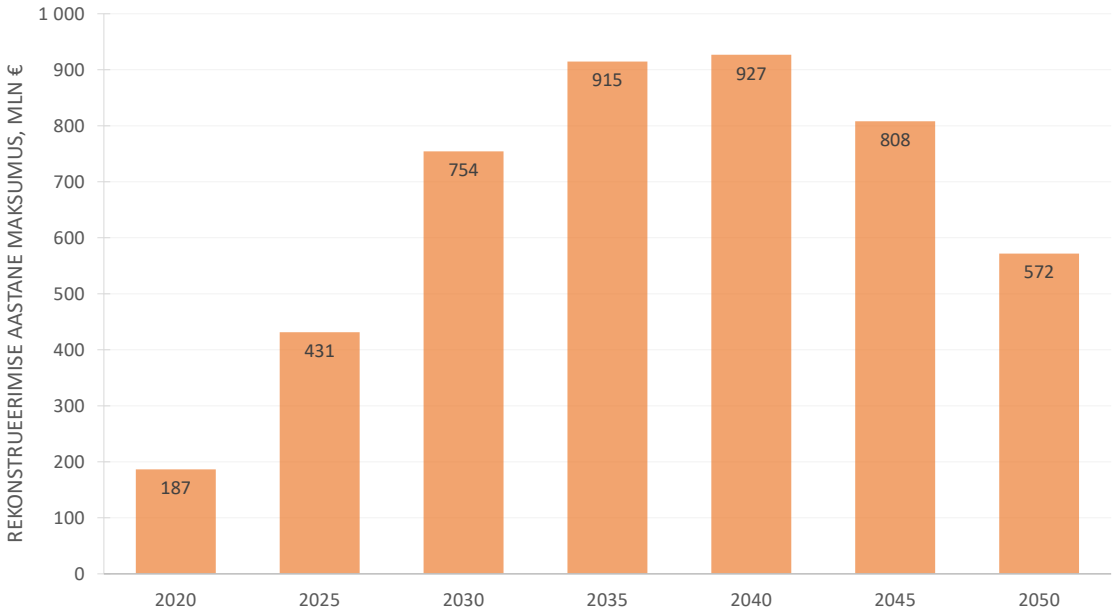


Figure 2. Annual financing needs for the full renovation of the buildings.

Rekonstrueerimise aastane maksumus, mln €	Annual cost of renovation, €M

The possible government aid will take into account the financial support for current measures and the renovation costs in 2019. The strategy proposes a new measure for private-sector non-residential buildings as there have been no renovation measures for these so far. The more specific aid projection for the country covers the period until 2030. It is practicable to specify the need for financial support in the upcoming periods later because during the step-by-step implementation of the strategy, the financing logic, market capacity and needs will change and savings due to development and innovation might occur.

Table 3. Support needs until 2030.

		Renovation support, €M	
	Support, %	**2021-2025**	**2026-2030**
Private houses	30	48	114
Apartment buildings	40	273	381
Private-sector non-residential buildings	40	152	324
Local government buildings	50	204	435
Central-government buildings	100*	119	142
		796	**1,396**

* This is not the usual financial support as the central government is the owner of the buildings.

If the financial support amounts to €370 M a year, almost €300 M will be returned to the state budget as taxes each year.

The financial support needed to launch investments in full renovation will grow from the current almost €90 M a year to the maximum of €370 M in 2035. As the average tax revenue from renovation is 32%, almost €300 million a year will be returned to the state budget as taxes

if the annual total investment in renovations is around €930 M. On the basis of this strategy, it is possible to prepare funding decisions when drawing up the state budget.

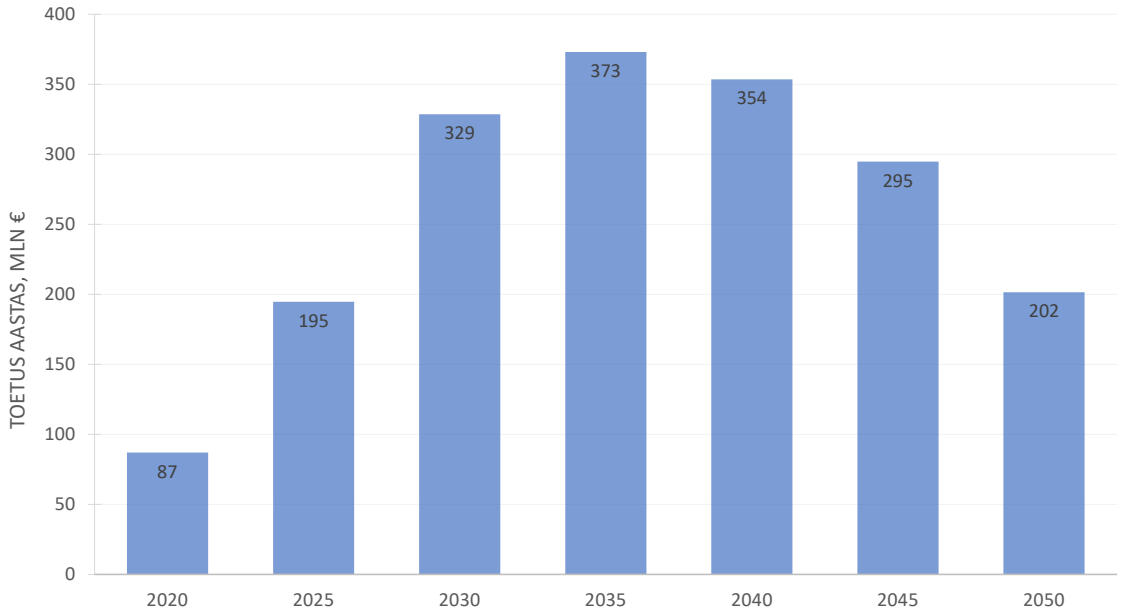


Figure 3. Annual financial support for the full renovation of the buildings.

Toetus aastas, mln €	Annual support, €M

Balanced regional development is possible with the help of an €8.4-billion fund that includes 10% of state resources.

Besides financial support, the strategy proposes the creation of additional services by the KredEx Foundation. These should also significantly increase the investments in housing by involving private partners as financiers, thus reducing the load on the state budget. This will speed up renovation of apartment buildings, increase the rental housing stock and use a counter-cyclical measure to even out the fluctuations in construction volumes. According to one possible scenario, for all the needs pointed out in this strategy to be covered, the following estimated prerequisites should be met:

- The annual financing needs will be around €220 M in the beginning years, while the state contribution would presumably be 10%, i.e. the state should cover one-tenth of the amount.
- The total financing need by 2050 will be €8.4 billion.
- The state will get back around 30% of the construction costs as taxes, i.e. the related tax revenue would be 70-170 M a year.

Loans and guarantees are necessary for regions where the property values are lower.

Some financial costs will be incurred when the national renovation loan is launched and guarantees are provided for the renovation of private houses:

- The loan measure would be meant for apartment associations to whom commercial banks are not willing to lend as much as needed for renovation. The capital needed to launch the loan measure is around €5 M a year.
- To renovate private houses in regions where property values are lower, it must be possible to use state guarantees. These would allow banks to issue loans independent of the value of the collateral. The capital needed to launch the guarantee measure is around €1 M a year.

Investments in R&D result in savings on renovation costs.

During the implementation of the strategy, financial support needs to be given to demolition of buildings that have fallen out of use. It was projected that, by 2050, up to 10 M square metres of apartment buildings and non-residential buildings will fall out of use. As the demolition cost of one square metre is €50, the financing needs for demolition work might be up to €15 M a year.

Energy savings of 7 TWh/y means the final energy consumption will shrink 60%.

The R&D financing needs are estimated to be 1% of the state contribution. This should ensure the activities are knowledge-based and there will be savings on renovation costs in the long term. The annual financing needs of the R&D&I activities are up to €4 M.

A final energy consumption reduction of around 7 TWh/y would be possible if the buildings were fully renovated. It would be possible to lower the heating consumption by up to 70% (~6.4 TWh/y) and electricity consumption by up to 20% (~0.5 TWh/y). The modest reduction in electricity consumption is due to the buildings where there is no compliant interior climate, but it can be achieved by the installation of the appropriate building services systems that use electricity. The renewable electricity support measure helping to increase the electricity savings when necessary is not taken into account here.

4 M tonnes less CO_2 emissions a year means 90% less GHG emissions.

Considering the renovation volumes proposed in the strategy and the reduction of the specific emissions of CO_2 from the electricity and district heating, as estimated in the analysis of opportunities to raise Estonia's climate ambitions, the CO_2 emissions reduction potential of the existing buildings is around 90% (~4 M t CO_2/y).

The implementation of the strategy requires speedy action; otherwise, the targets set for the first decade will not be met.

To sum up, the strategy presents the long-term vision for the renovation of buildings and describes the activities and volumes necessary for attaining the goal. On the basis of the strategy, it would be possible to start looking for the financing sources needed for implementing it and to plan detailed support measures. The projections in this strategy are needs-based and do not reflect the current volume of funds for this purpose. The prerequisites for implementing the activities foreseen in this strategy are their inclusion in the national strategic planning and budgeting processes and optimal use of the funds earmarked for this purpose. Due to the limited public-

sector resources, financing has to be found from various EU funds (funds planned in Estonia and central funds), revenues from trading GHG emission allowances, other state budget resources and private funds through market-based services.

2 Contents

3 Introduction

The energy and climate policy objectives of Estonia are stipulated in the National Development Plan of the Energy Sector until 2030 (NDPES 2030), the General Principles of Climate Policy until 2050 (GPCP 2050), the Climate Change Adaptation Development Plan until 2030 and Estonia's 2030 National Energy and Climate Plan (NECP 2030). To improve the energy performance of the existing building stock, NDPES 2030 set targets for housing renovation and the demolition of apartment buildings fallen out of use. The targets were proposed to be achieved by the more active renovation of residential and non-residential buildings, encouraged by support and loan measures.

Table 4. Targets set in NDPES 2030.

	Net area, m²	Quantity
Residential buildings renovated with the help of financial support		
Apartment buildings	17 million	
Private houses	10 million	
Apartments and private houses with improved energy use		320,000
Renovated buildings in the total building stock		
Apartment buildings (class C)		50%
Private houses (class C or D)		40%
Demolition of apartment buildings fallen out of use		250

According to NECP 2030, the objective of Estonia for 2030 is to keep the final energy consumption at the current 32-33 TWh/y and to reduce the primary energy consumption up to 14%, both with the help of the proposed energy savings measure. To attain this objective, the following measures for the existing building stock have been proposed:

- the renovation of public-sector and commercial buildings (HF1);
- the renovation of private houses and apartment buildings (HF2);
- the additional renovation of public-sector and commercial buildings (HF5);
- the additional renovation of private houses and apartment buildings (HF6).

The main aim of this long-term strategy for housing renovation is a cost-effective renovation of the existing building stock into nearly zero energy buildings by 2050. In Estonian laws and regulations on the energy performance of buildings, the cost-optimal energy performance level for a major renovation is energy class C.[3]

The objective is laid down in the renewed Energy Performance of Buildings Directive[4], according to which the CO_2 emissions of the building stock must be reduced by 2050. To achieve the energy performance targets, the average annual renovation rate has to be 3%; this would make the energy use of the building stock start to diminish. Whereas, it is important that the energy performance measures to be applied not focus only on building envelopes but also cover building services systems and ensure a healthy interior climate. Long-term renovation strategies focus on financial mechanisms and stimuli for removing market failures

and on involving financial institutions so that the private sector could make large investments in building renovation to improve their energy performance. The strategy includes measures such as facilitation of lending for improving the energy performance of buildings, facilitation of public sector investments in the building stock of high energy performance, public-private partnerships, reduction of possible investment risks, financial support and creation of a revenue base needed for financing the measures.

The strategy has an extremely large social dimension as it is estimated that it would improve the living and working conditions of 80% of our population. The renovation of homes and workspaces as well as tearing down all derelict buildings will make the building stock safer, of better aesthetic quality, better for health, better accessible and more affordable.

This building renovation strategy is also linked to the EU Circular Economy Action Plan[5], one focus of which is construction, buildings and preparation of a holistic and sustainable strategy for the built environment, to promote circularity principles for buildings. In the future, buildings should be renovated in view of the circular economy principles (i.e. construction materials containing recycled material, building passports and green public procurements).

To attain this objective, it is necessary to establish, in addition to the final goal, the expected results and milestones of the renovation strategy for 2030, 2040 and 2050.

This project involved Jüri Rass, Ivo Jaanisoo, Ivan Sergejev and Regina Valt from the construction and housing department of the Estonian Ministry of Economic Affairs and Communications as clients. The steering committee for preparing the strategy included Triin Reinsalu from the KredEx Foundation (SA Kredex), Raul Prank from the State Real Estate Company (Riigi Kinnisvara AS), Veronika Ilsjan, Eve Murumaa, Lauri Lelumees, Mari Lahtmets and Tarmo Kivi from the Ministry of Finance, and Hanna Jemmer and Irje Möldre from the energy department of the Ministry of Economic Affairs and Communications. The report on the strategy was drawn up by the nearly zero energy building research team of the Civil Engineering and Architecture Department, Tallinn University of Technology (TalTech): Jarek Kurnitski, Kalle Kuusk, Helena Kuivjõgi, Lauri Lihtmaa, Aivar Uutar, Ergo Pikas, Targo Kalamees, Raimo Simson.

[3] Tallinn University of Technology. Analysis of cost-optimal minimum energy efficiency requirements for buildings. 2017

[4] Directive (EU) of the European Parliament and of the Council,, https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32018L0844&from=EN.

[5] A new Circular Economy Action Plan. https://ec.europa.eu/environment/circular-economy/index_en.htm.

4 Overview of final energy consumption

In 2018, the final energy consumption was 35 TWh in Estonia.

It has stayed between 31 TWh and 35 TWh for the recent 15 years.[6] Final consumption is more affected by business cycles than by the outdoor climate. The consumption was the biggest, 35.8 TWh, in 2007, at the peak of the business cycle. Along with the downturn, the final consumption fell 12% in two years, reaching 31.4 TWh in 2009. The winters of 2010 and 2012 were colder than average, and the energy consumption rose a bit then. The winter of 2015, which was warmer than average, did not affect final energy consumption. Since 2016, the final energy consumption has been rising and reached 35 TWh again in 2018. The years 2016, 2017 and 2018 have seen quite similar outdoor climate conditions.

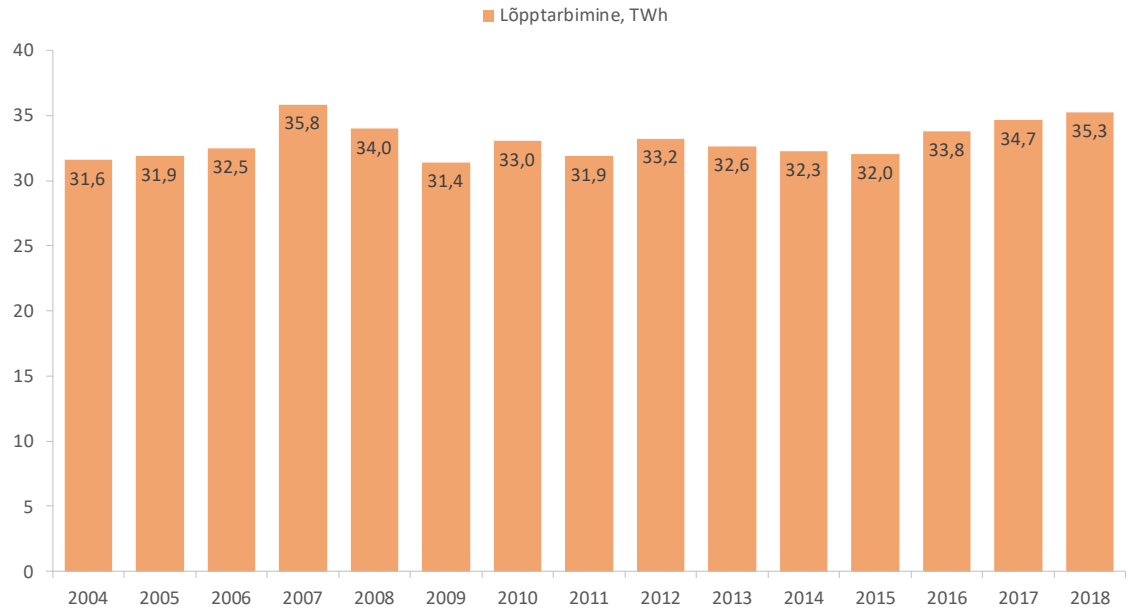


Figure 4. Final Energy Consumption.

Lõpptarbimine, TWh	Final consumption, TWh

Energy consumption by household accounts for the biggest part of the final energy consumption: 40%. Transport and industry each account for 21%. Commercial and public service sectors account for 15% of the final consumption.

Table 5. Final Energy Consumption 2018, TWh.

	Fuels	District heating	Electricity	Total	Percentage
Industry	2.60	2.06	2.65	7.3	21%
Agriculture and Fisheries	0.83	0.07	0.17	1.1	3%
Transport	7.23	0.04	0.09	7.4	21%
Commercial and public services	0.64	2.20	2.53	5.4	15%
Households	8.48	3.75	1.86	14.1	40%
Final consumption	**19.8**	**8.1**	**7.3**	**35.2**	

[6] Statistics Estonia. KE024: ENERGY BALANCE SHEET BY TYPE OF FUEL OR ENERGY

Fuel consumption accounts for the biggest part of the consumption, compared to district heating and electricity. Fuels include, for example, woodfuels, gas, fuel oil, diesel fuel and petrol.

4.1 Energy consumption in buildings

Energy consumption of residential buildings is ~11 TWh and that of non-residential buildings, ~6 TWh.

The data of Statistics Estonia regarding the commercial and public services sector also include the consumption of diesel fuel and petrol not directly related to the energy consumption of buildings. Energy consumption of residential and non-residential buildings can be estimated after the final consumption of diesel fuel and petrol is moved from under households and commercial and public services sectors to the transport sector.

Table 6. Final Energy Consumption 2018, TWh.

	Fuels	District heating	Electricity	Total	Percentage
Industry	2.60	2.06	2.65	7.3	21%
Agriculture and Fisheries	0.83	0.07	0.17	1.1	3%
Transport	10.63	0.04	0.09	10.8	30%
Non-residential buildings	0.45	2.20	2.53	5.2	15%
Residential buildings	5.28	3.75	1.86	10.9	31%
Final consumption	**19.8**	**8.1**	**7.3**	**35.2**	

The annual energy consumption of residential buildings has been relatively stable, between 10 and 12 TWh. Around 85% of the consumption is heating (~9 TWh) and ~15%, electricity (~2 TWh). Over the years, the share of electricity consumption has increased in the energy consumption of residential buildings.

The final energy consumption of non-residential buildings as increased as well. In 2004, non-residential buildings consumed 4 TWh of energy. By 2017, their consumption had increased 50%, reaching 6 TWh. Around 50% of the consumption of non-residential buildings is heat consumption (~3 TWh) and the other 50%, electricity (~3 TWh).

The energy consumption of buildings is significantly affected by outdoor climate. The winters of 2010 and 2012, which were colder than average, caused the consumption to increase. The winter of 2015, which was warmer than average, reduced the energy consumption by buildings.

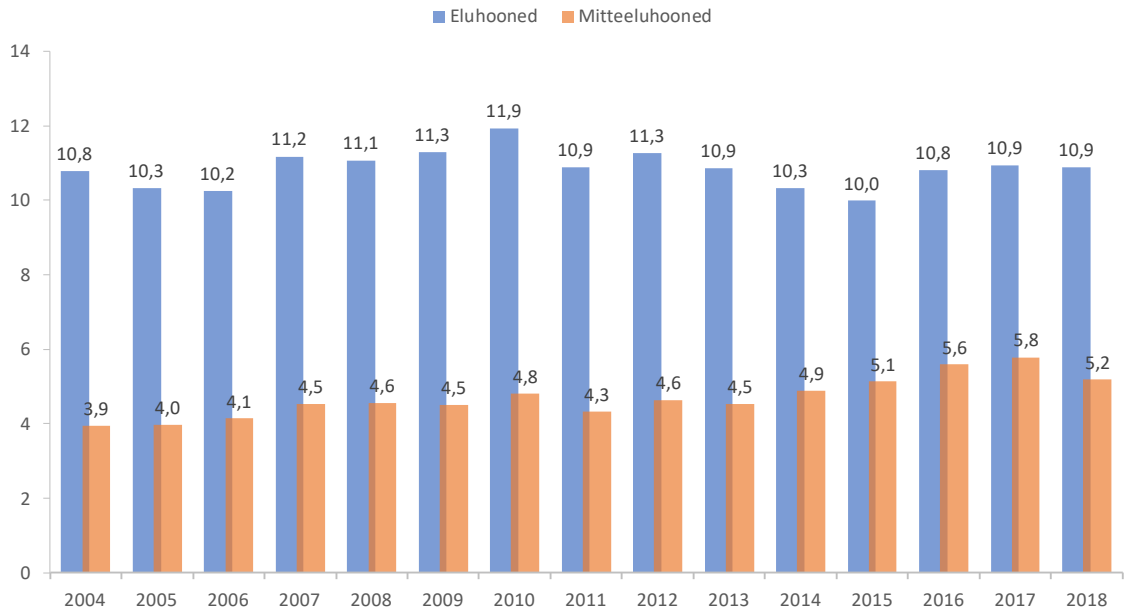


Figure 5. Final energy consumption in buildings.

Eluhooned	Residential buildings
Mitteeluhooned	Non-residential buildings

5 Overview of building stock

5.1 Residential buildings

Most of the Estonian residential buildings are in private ownership. According to the population and housing census of 2011[7], 97% of dwellings were in private ownership. State or local authorities owned just 2% of dwellings.

Residential buildings are mostly privately owned.

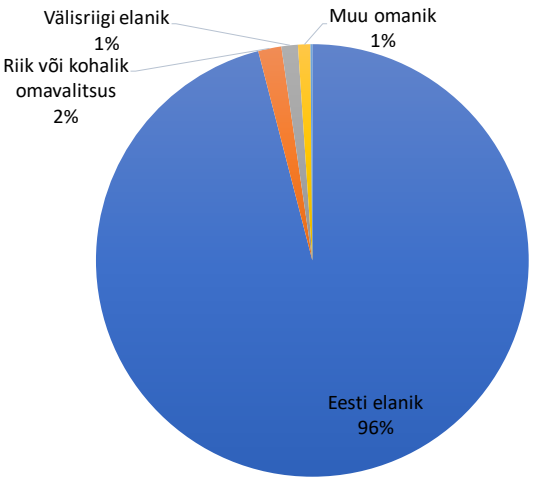


Figure 6. Residential buildings, by owner.

The renovation strategy covers buildings constructed before 2000 (included). Buildings constructed later have higher energy performance. According to the survey of apartment buildings taken into use in the period from 1990 to 2010, their average space heating energy consumption was 102 kWh/m^2/y.[8] According to the survey of apartment buildings made of bricks, their average space heating energy consumption was 150 kWh/m^2/y.[9] The thermal conductivity of the building envelope of houses constructed after 2000 is significantly lower than that of those constructed before 1990. In general, the former do not need a full renovation that includes adding insulation to the envelope. The renovation would mostly cover modernisation of building services systems and addition of local renewable energy production. The strategy focuses on buildings that were erected before 2000 and need a full renovation. These account for the biggest part of the building stock.

According to the population and housing census of 2011, 93% apartments and 89% of private houses of known construction date have been taken into use before 2000.

Välisriigi elanik	Foreign resident
Riik või kohalik omavalitsus	State or local government
Muu omanik	Other owner

[7] Statistics Estonia. RL0206. Occupied conventional dwellings by type of building, owner and location.

Eesti elanik	Estonian resident

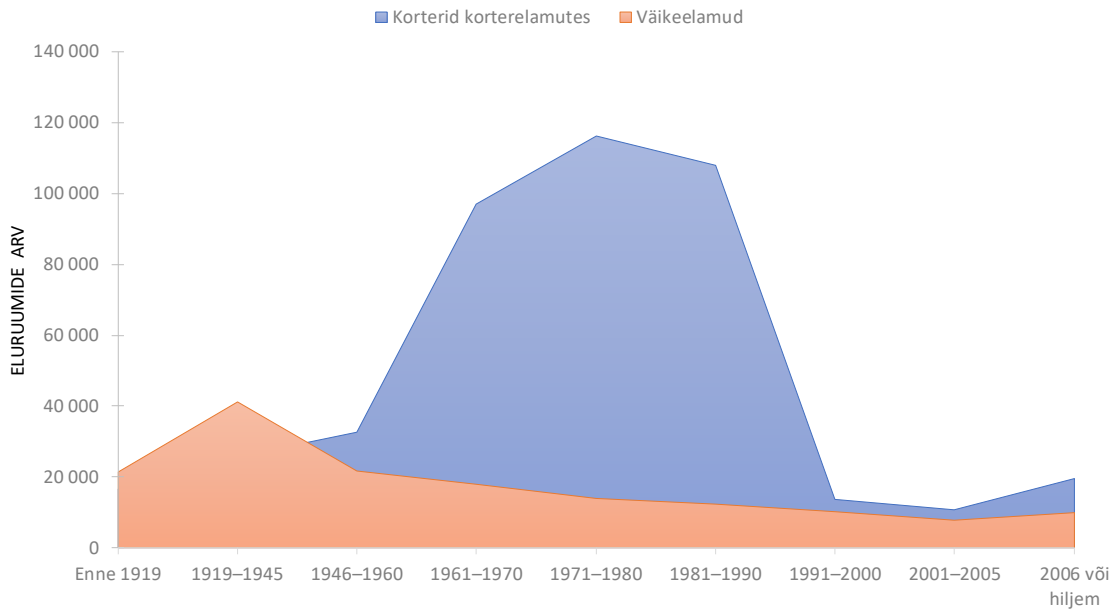


Figure 7. Dwellings, by year of taking into use.

Korterid korterelamutes	Apartments in apartment buildings
Väikeelamud	Small residential buildings
Eluruumide arv	Number of dwellings
Enne 1919	Before 1919
2006 või hiljem	2006 or later

According to the Building Registry, the number of energy performance certificates issued on the basis of consumption data for residential buildings taken into use before 2000 (included) amounts to 3 200. On the scale of energy performance, class A refers to nearly zero energy buildings and class C, energy performance after a major renovation. Class A, B or C has been awarded to only 22% of small residential buildings and 9% of apartment buildings with an energy performance certificate.

[8] Tallinn University of Technology. Eesti eluasemefondi ehitustehniline seisukord – ajavahemikul 1990–2010 kasutusele võetud korterelamud *[State of repairs of Estonian housing stock: apartment buildings constructed between 1990 and 2010]*. 2012

[9] Tallinn University of Technology. Eesti eluasemefondi telliskorterelamute ehitustehniline seisukord ning prognoositav eluiga *[State of repairs and estimated life span of brick apartment buildings in Estonian housing stock]* 2010.

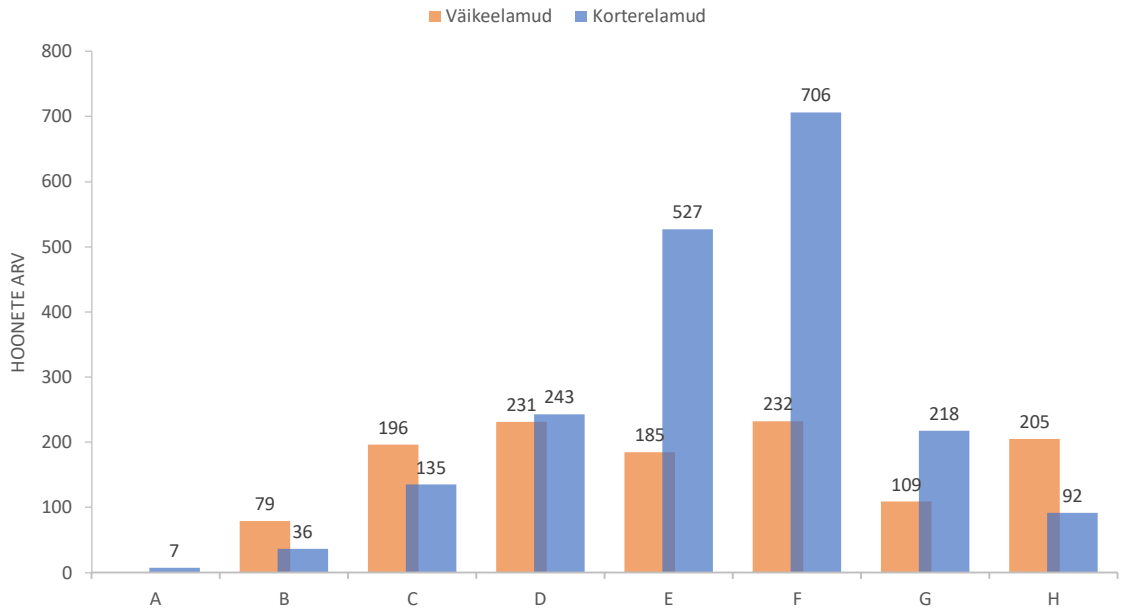


Figure 8. Energy performance certificates of residential buildings taken into use before 2000.

Väikeelamud	Small residential buildings
Korterelamud	Apartment buildings
Hoonete arv	Number of buildings

5.2 Number and location of private houses

The number of private houses taken into use before 2000 and still in use is 155,000, and their total floor area amounts to 20 million square metres.

According to the Building Registry, the number of private houses of known area taken into use before 2000 (included) is 155,150, their total floor area amounting to 19,998,000 square metres. The percentage of private houses is rather similar in all counties. The number and floor area of private houses exceed 10% in three counties: Harju, Tartu and Pärnu Counties.

Table 7. Private houses, by counties.

	Number of private houses		Net floor area, m²	
Harju County	28,130	18%	4,003,000	20%
Hiiu County	3,250	2%	347,000	2%
Ida-Viru County	8,270	5%	876,000	4%
Jõgeva County	7,930	5%	1,042,000	5%
Järva County	7,200	5%	952,000	5%
Lääne County	4,090	3%	487,000	2%
Lääne-Viru County	13,400	9%	1,602,000	8%
Põlva County	6,480	4%	743,000	4%
Pärnu County	15,280	10%	2,024,000	10%
Rapla County	8,100	5%	1,177,000	6%
Saare County	8,350	5%	960,000	5%
Tartu County	17,290	11%	2,512,000	13%
Valga County	6,650	4%	710,000	4%
Viljandi County	11,170	7%	1,564,000	8%
Võru County	9,600	6%	1,001,000	5%
Total	**155,150**		**19,998,000**	

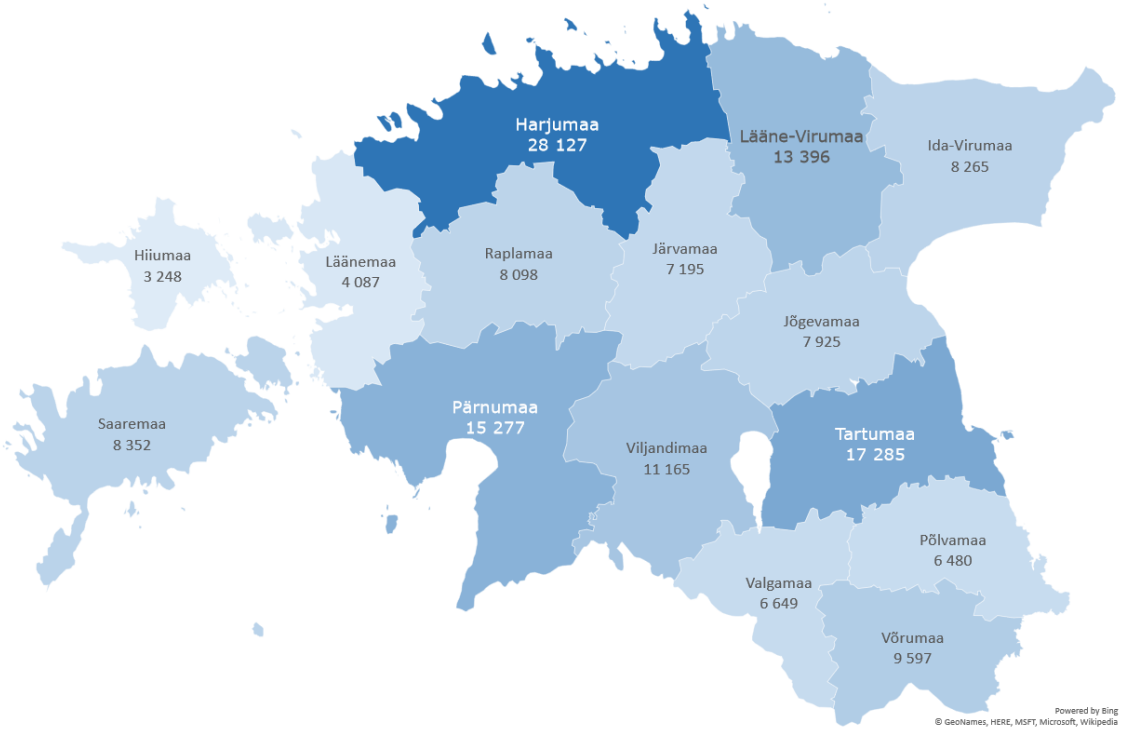


Figure 9. Private houses constructed before 2000 still in use (data based on the administrative divisions of 2019).

Hiiumaa	Hiiu County
Saaremaa	Saare County
Läänemaa	Lääne County
Harjumaa	Harju County
Lääne-Virumaa	Lääne-Viru County
Ida-Virumaa	Ida-Viru County
Raplamaa	Rapla County
Järvamaa	Järva County
Jõgevamaa	Jõgeva County
Pärnumaa	Pärnu County
Viljandimaa	Viljandi County
Tartumaa	Tartu County
Valgamaa	Valga County
Põlvamaa	Põlva County
Võrumaa	Võru County

5.3 Number and location of apartment buildings

The number of apartment buildings taken into use before 2000 still in use is 22,000, their total floor area amounting to 28 million square metres.

According to the Building Registry, the number of apartment buildings of known floor area taken into use before 2000 (included) is 22,600, their total area amounting to 28,378,000 square metres. The three counties with the biggest area of apartment buildings (Harju, Ida-Viru and Tartu Counties) account for 71% of their total floor area. Around one-third of apartment buildings and almost half of their floor area are in Harju County.

46% of their total floor area is in Harju County.

Table 8. Apartment buildings, by county.

	Number of apartment buildings		Net floor area, m²	
Harju County	8,060	36%	12,956,000	46%
Hiiu County	160	1%	114,000	0.4%
Ida-Viru County	2,140	9%	4,230,000	15%
Jõgeva County	690	3%	559,000	2%
Järva County	760	3%	715,000	3%
Lääne County	520	2%	489,000	2%
Lääne-Viru County	1,490	7%	1,361,000	5%
Põlva County	460	2%	428,000	2%
Pärnu County	2,110	9%	1,605,000	6%
Rapla County	650	3%	564,000	2%
Saare County	540	2%	454,000	2%
Tartu County	2,480	11%	2,803,000	10%
Valga County	600	3%	582,000	2%
Viljandi County	1,270	6%	881,000	3%
Võru County	690	3%	638,000	2%
Total	**22,600**		**28,378,000**	

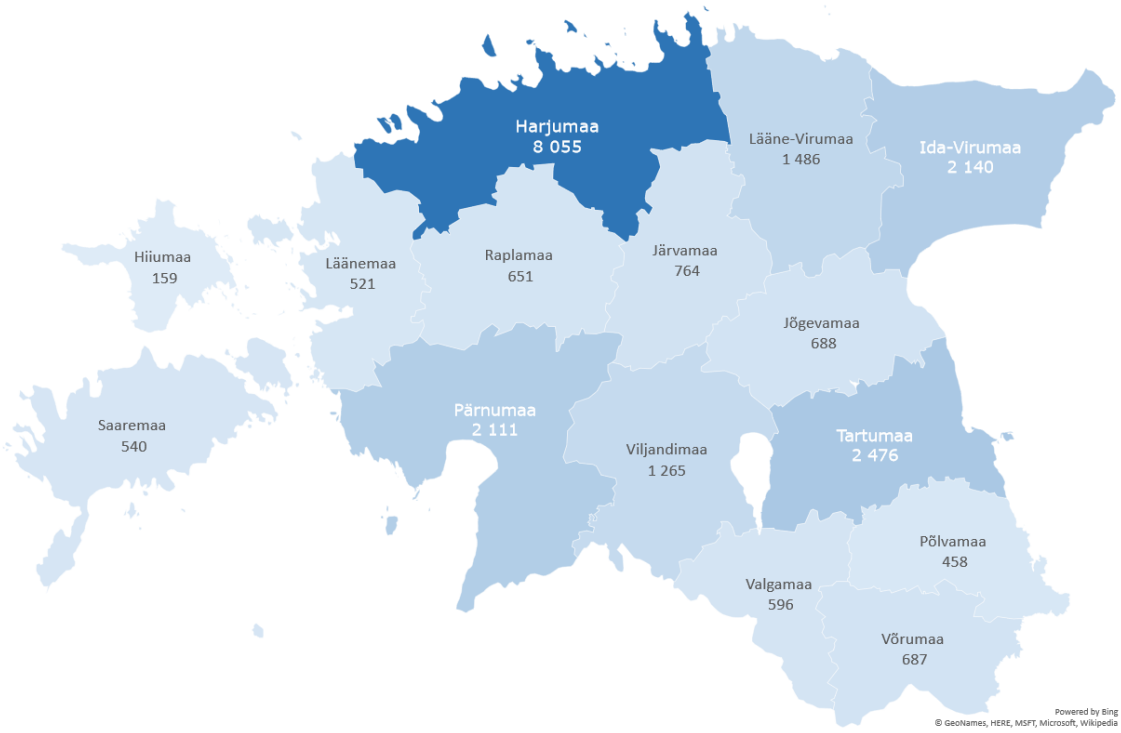


Figure 10. Apartment buildings constructed before 2000 still in use (data based on the administrative divisions of 2019).

Hiiumaa	Hiiu County
Saaremaa	Saare County
Läänemaa	Lääne County
Harjumaa	Harju County
Lääne-Virumaa	Lääne-Viru County
Ida-Virumaa	Ida-Viru County
Raplamaa	Rapla County
Järvamaa	Järva County
Jõgevamaa	Jõgeva County

Pärnumaa	Pärnu County
Viljandimaa	Viljandi County
Tartumaa	Tartu County
Valgamaa	Valga County
Põlvamaa	Põlva County
Võrumaa	Võru County

5.4 Residential buildings, by location in functional regions

Based on their floor area, 81% of the apartment buildings are in county and second-tier centres.

As for residential buildings, besides administrative divisions, functional regions[10] need to be considered. The subdivisions of functional regions largely coincide with the property value regions[11], and these subdivisions also reflect people's ability to renovate their housing on market terms and conditions. The property value of apartments is an indicator of the economic capacity of the area. In areas further away from centres, renovation is more difficult because there are more residential buildings emptying in peripheries, smaller organisational capacity, smaller contributions to the renovation fund, etc. Renovation analyses regarding apartment buildings have indicated a correlation between renovation activity and property prices.

As for small residential buildings, area-wise, these are distributed evenly throughout the subdivisions. Apartment buildings, however, have concentrated into centres of functional regions and second-tier centres: 81% of their floor area is there.

Table 9. Residential buildings, by location in functional regions.

	Number of private houses		**Net floor area, m²**	
Centre of functional region	34,500	22%	4,856,000	24%
Second-tier centre	15,900	10%	2,065,000	10%
Immediate hinterland	40,400	26%	5,332,000	27%
Transitional area	32,700	21%	3,953,000	20%
Periphery	31,600	20%	3,792,000	19%
TOTAL	**155,100**		**19,998,000**	
	Number of apartment buildings		**Net floor area, m²**	
Centre of functional region	13,200	58%	20,133,000	71%
Second-tier centre	2,400	11%	2,822,000	10%
Immediate hinterland	3,000	13%	2,312,000	8%
Transitional area	2,100	10%	1,699,000	6%
Periphery	1,900	8%	1,411,000	5%
TOTAL	**22,600**		**28,378,000**	

[10] Toimepiirkondade määramine *[Identification of Functional Regions]*. Ministry of the Interior, Statistics Estonia. 2014

[11] Korterelamute renoveerimistoetuste meetme arendus *[Development of apartment building renovation measure]*. MTÜ Tartu Regiooni Energiaagentuur *[Tartu Regional Energy Agency, NGO]*. 2018 https://www.mkm.ee/sites/default/files/trea_renoveerimismeetmete_uuring_lopparuanne.pdf.

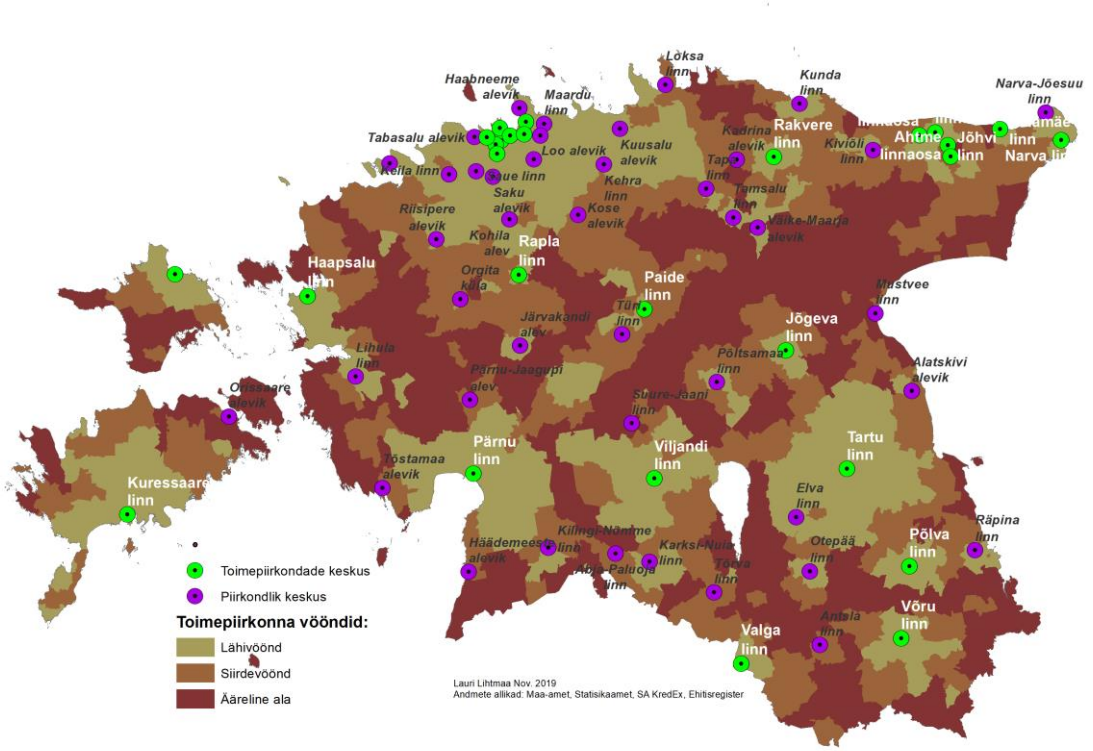


Figure 11. Functional region subdivisions and centres.

Kuressaare linn	Kuressaare city
Haapsalu linn	Haapsalu city
Rapla linn	Rapla city
Paide linn	Paide city
Rakvere linn	Rakvere city
Ahtme linnaosa	Ahtme district
Jõhvi linn	Jõhvi city
Narva linn	Narva city
Sillamäe linn	Sillamäe city
Jõgeva linn	Jõgeva city
Pärnu linn	Pärnu city
Viljandi linn	Viljandi city
Tartu linn	Tartu city
Põlva linn	Põlva city
Valga linn	Valga city
Võru linn	Võru city
Orissaare alevik	Orissaare small town
Haabneeme alevik	Haabneeme small town
Tabasalu alevik	Tabasalu small town
Maardu linn	Maardu city
Keila linn	Keila city
Loo alevik	Loo small town
Saue linn	Saue city
Saku alevik	Saku small town
Riisipere alevik	Riisipere small town
Kohila alev	Kohila town
Orgita küla	Orgita village

Loksa linn	Loksa city
Kuusalu alevik	Kuusalu small town
Kehra linn	Kehra city
Kose alevik	Kose small town
Kunda linn	Kunda city
Kadrina alevik	Kadrina small town
Tapa linn	Tapa city
Tamsalu linn	Tamsalu city
Väike-Maarja alevik	Väike-Maarja small town
Kiviõli linn	Kiviõli city
Narva-Jõesuu linn	Narva-Jõesuu city
Mustvee linn	Mustvee city
Alatskivi alevik	Alatskivi small town
Järvakandi alev	Järvakandi town
Lihula linn	Lihula city
Türi linn	Türi city
Põltsamaa linn	Põltsamaa city
Suure-Jaani linn	Suure-Jaani city
Elva linn	Elva city
Räpina linn	Räpina city
Otepää linn	Otepää city
Antsla linn	Antsla city
Tõstamaa alevik	Tõstamaa small town
Häädemeeste alevik	Häädemeeste small town
Kilingi-Nõmme linn	Kilingi-Nõmme city
Abja-Paluoja linn	Abja-Paluoja city
Karksi-Nuia linn	Karksi-Nuia city
Tõrva linn	Tõrva city
Toimepiirkondade keskus	Centre of functional regions
Piirkondlik keskus	Second-tier centre
Toimepiirkonna vööndid:	Functional region subdivisions
Lähivöönd	Immediate hinterland
Siirdevöönd	Transitional area
Ääreline ala	Periphery
Lauri Lihtmaa Nov 2019	Lauri Lihtmaa Nov 2019
Andmete allikad: Maa-amet, Statistikaamet, SA KredEx, Ehitisregister	Data sources: Land Board, Statistics Estonia, SA KredEX, Building Registry

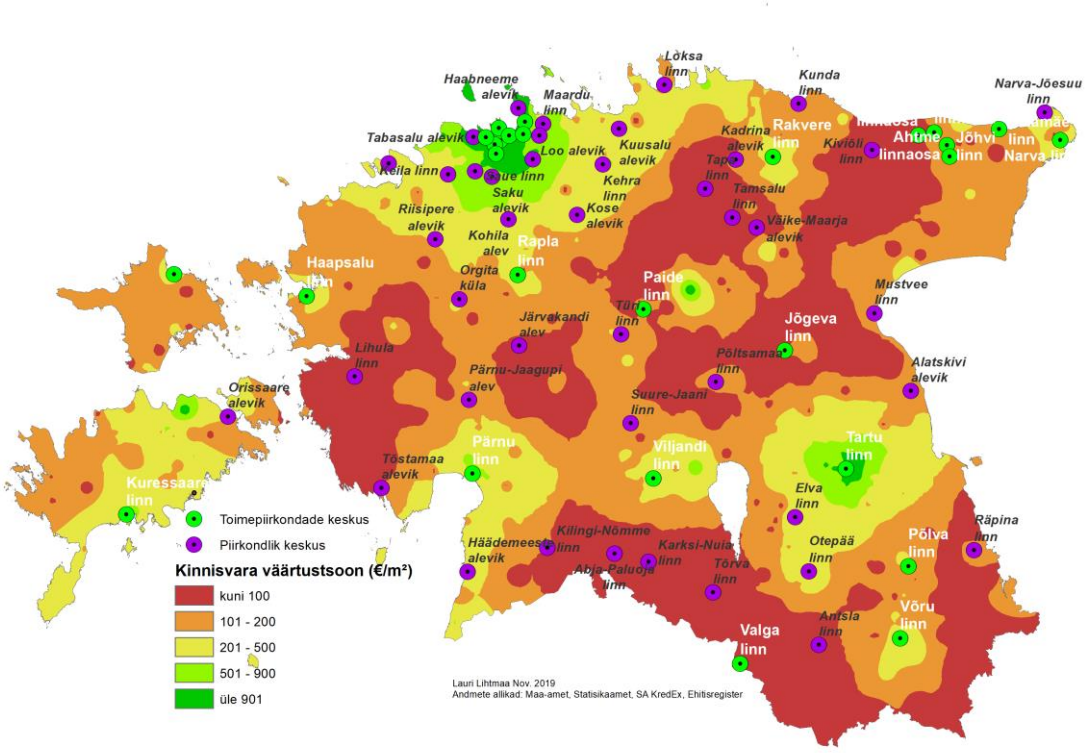


Figure 12. Apartment value regions.

5.5 Residential buildings emptying and falling out of use

Internal migration and urbanisation are the main causes of residential buildings falling out of use.

Residential buildings getting empty and falling out of use is directly linked to demographic changes. According to the population projection[12] of Statistics Estonia, the population of Estonia will shrink 2.7% by 2045. The age distribution of the population will also change. By 2060, the share of people aged 65+ will grow from the current 20% to 30%.

Changes in counties vary. According to the projection, the population of Ida-Viru, Järva, Valga and Jõgeva counties will diminish by one-third. The population of Harju County will grow. Smaller increases in the population are expected for Tartu County as well.

In addition, there will be changes within the counties. Settlements outside centres will gradually become empty due to urbanisation and regional immigration.

[12] Statistikaameti rahvastikuprognoos aastani 2080 *[Statistics Estonia's population projection up to 2080]*. https://www.stat.ee/news-release-2019-077.

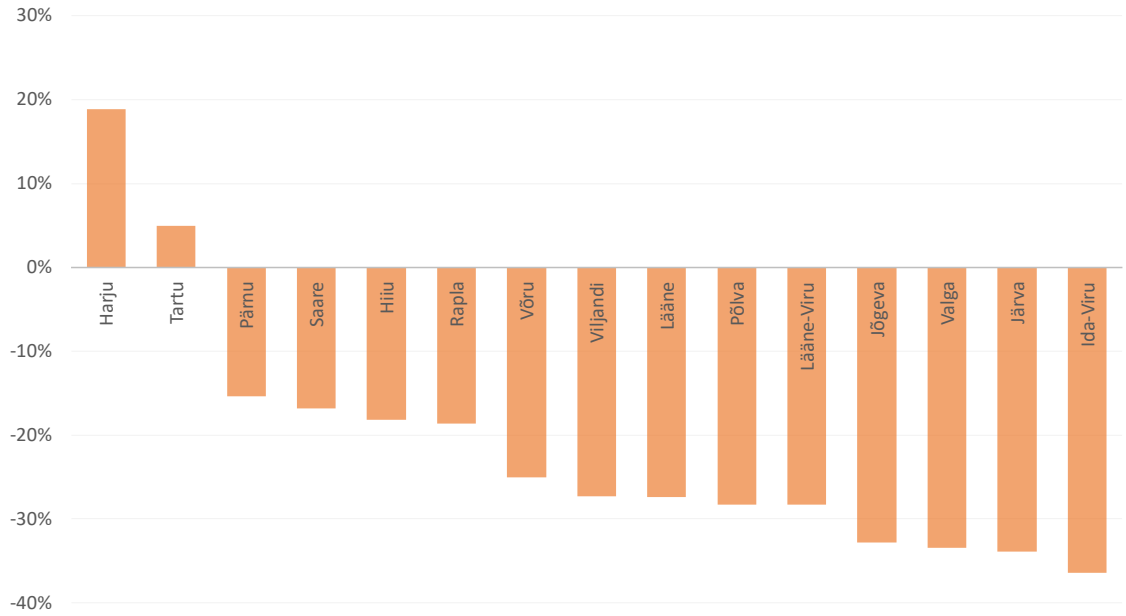


Figure 13. Projection of population changes in counties by 2045.

Empty apartment buildings create bigger problems than private houses. Apartment buildings are getting empty step by step until the remaining residents are no longer able to keep the building in a good state of repair or renovate it as needed. Emptying apartment buildings are a problem for local authorities and the central government as well. To solve the problem of emptying apartment buildings, a pilot project[13] has been launched in three municipalities to find solutions to the problem of empty and half-empty apartment buildings, both for the municipalities and the locals. The project looks for solutions such as how to move people to sustainable apartment buildings and to tear down the empty apartment buildings that are partially in private ownership.

Up to 25% of private houses (~40,000) and up to 23% apartment buildings (~5,300) might fall out of use.

According to the projections, around 40,000 private houses (~4.8 M m^2) and 5,300 apartment buildings (~5 M m^2) might fall out of use by 2050. Changes in population numbers affect the peripheries of functional regions the most, as these are projected to be the first to become empty. While in centres, less than 10% of residential buildings is expected to fall out of use, this indicator might be as high as 80% in the peripheries of functional regions.

As for empty private houses, it is likely that not all of them will be vacant. Instead, they will be seasonally used as a summer or country house.

Table 10. Residential buildings falling out of use in functional region subdivisions.

	Number of private houses		Net floor area, m^2	
Centre of functional region	1,500	4%	160,000	3%

[13] https://www.rahandusministeerium.ee/et/eesmargidtegevused/riigivara/tuhjenevate-korterelamute-projekt.

Second-tier centre	700	5%	83,000	4%
Immediate hinterland	2000	5%	200,000	4%
Transitional area	11,000	34%	1,300,000	33%
Periphery	25,000	80%	3,000,000	80%
TOTAL	**40,000**	**25%**	**4,800,000**	**24%**

	Number of apartment buildings		**Net floor area, m²**	
Centre of functional region	500	4%	1,100,000	6%
Second-tier centre	300	12%	300,000	11%
Immediate hinterland	1,000	34%	700,000	30%
Transitional area	1,700	80%	1,400,000	80%
Periphery	1,800	95%	1,400,000	95%
TOTAL	**5,300**	**23%**	**4,900,000**	**18%**

5.6 Non-residential buildings

There are 32,000 non-residential buildings with climate control, their total floor area being 28 M square metres.

The Building Registry includes 375,000 non-residential buildings that are in use and have been taken into use before 2000 (included). Their total floor area amounts to 62 M square metres. There are non-residential buildings with climate control (office, educational and commercial buildings, etc.) and without (ancillary buildings of residential buildings, agricultural buildings, pumping stations, etc.). The strategy focuses on non-residential buildings with climate control. There are around 32,000 such buildings with the total floor area of 28 M square metres.

Table 11. Non-residential buildings with climate control.

	Quantity of buildings		**Net area, m²**	
OFFICE	4,010	13%	4,300,000	15%
ACCOMMODATION	2,340	7%	1,020,000	4%
COMMERCE AND SERVICES	6,710	21%	4,170,000	15%
EDUCATION, RESEARCH	1,990	6%	3,890,000	14%
HEALTHCARE	550	2%	1,050,000	4%
WAREHOUSES	7,590	24%	4,100,000	15%
INDUSTRY	7,920	25%	9,180,000	33%
SPECIAL-PURPOSE BUILDINGS	740	2%	420,000	1%
	31,850		**28,130,000**	

The non-residential buildings are mainly in centres. Based on their floor area, 70% of non-residential buildings are in the centres of functional regions or in second-tier centres. Area-wise, 6% of non-residential buildings are in the peripheries of functional regions.

Table 12. Non-residential buildings, by location in functional regions.

	Number of non-residential buildings		Net floor area, m²	
Centre of functional region	13,200	42%	16,790,000	60%
Second-tier centre	3,700	12%	3,010,000	11%
Immediate hinterland	6,220	20%	3,830,000	14%
Transitional area	4,570	14%	2,580,000	9%
Periphery	3,970	13%	1,760,000	6%
TOTAL	**31,800**		**28,000,000**	

Energy performance certificates issued on the basis of consumption data have been issued to 1700 non-residential buildings, i.e. 5% of all non-residential buildings with climate control. The biggest number of these certificates has been issued to office buildings (440), followed by nursery schools (390) and other schools (355). 27% of energy performance certificates issued to non-residential buildings are of class A, B or C. The biggest number of such certificates are of class D.

To ensure the energy performance of non-residential buildings, the State Real Estate Company Riigi Kinnisvara AS has drawn up guidance on the energy performance of non-residential buildings[14] and guidance for chief design engineers on ensuring energy performance of non-residential buildings[15].

[14] Riigi Kinnisvara AS. Madal- ja liginullenergiahooned *[Low and nearly zero energy buildings]*. https://rkas.ee/sites/default/files/public-uploaded-files/Uuringud/Madal_ja_liginullenergiahooned.PDF.

[15] Riigi Kinnisvara AS. Energiatõhususe juhendmaterjal ja metoodika peaprojekteerijatele ning arhitektidele *[Energy performance guidance material and methodology for chief design engineers and architects]*. https://rkas.ee/sites/default/files/public-uploaded-files/juhendid/Juhendmaterjal%202017%2010.pdf.

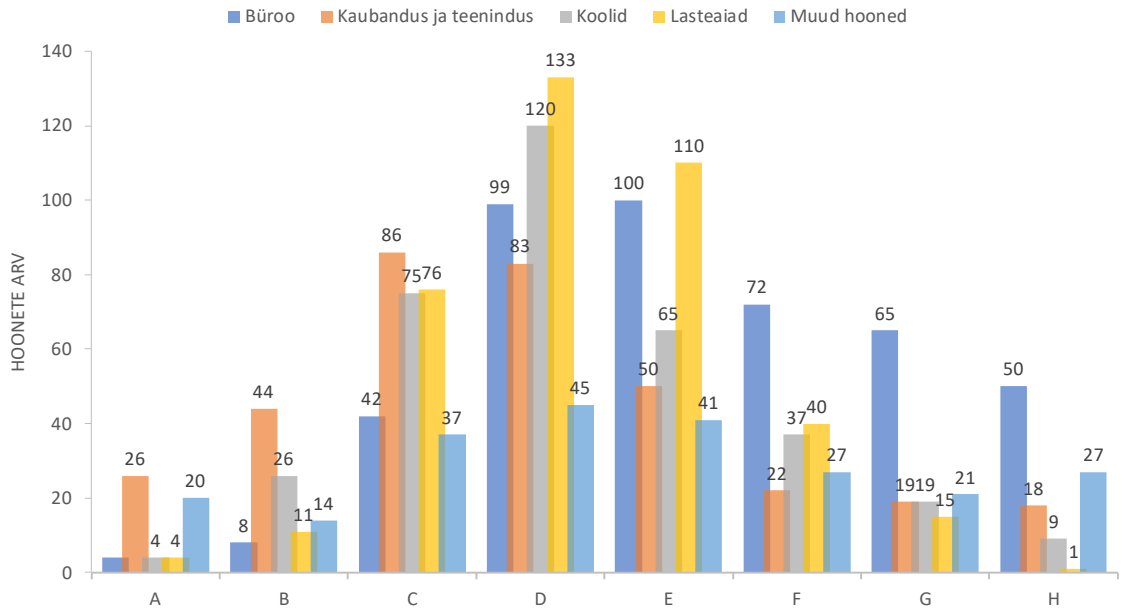


Figure 14. Energy performance certificates of non-residential buildings taken into use before 2000.

Büroo	Office
Kaubandus ja teenindus	Commerce and services
Koolid	Schools
Lasteaiad	Nursery schools
Muud hooned	Other buildings
Hoonete arv	Number of buildings

5.7 Public sector

The data on the buildings of the central government is based on the data in the State Real Estate Registry.[16] Such buildings also include residential buildings owned by the central government. The percentage of government-owned residential buildings is small, and a large part of these are apartment buildings that have to be demolished in Ida-Viru County. The Real Estate Registry data do not contain information on buildings used by state foundations (~660,000 m^2) and buildings of bodies governed by public law (~800,000 m^2). There is no central database on all public sector buildings yet.[17]

According to the State Real Estate Registry, the property is managed by ministries, the Government Office, the Chancellery of the Riigikogu, the Office of the President, the Office of the Chancellor of Justice, the Supreme Court and the National Audit Office. Authorised users include subordinate entities, such as schools, museums, the State Forest Management Centre, the Rescue Board, etc. In 2018, the central government sector used a total of 2.3 million square metres of floor area, 1.4 million m^2 of which was owned by the central government and 860,000 m^2 it rented.

The floor area of real estate with climate control owned by the central

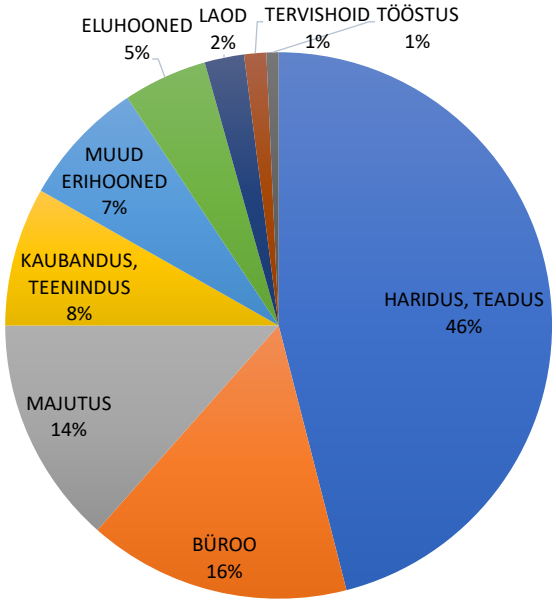
The strategy targets the buildings that are owned by the central government, in use, have climate control, are not under protection as heritage or culturally

[16] State Real Estate Registry. https://riigivara.fin.ee/kvr/.
[17] Ministry of Finance. Riigi kinnisvara valitsemise koondaruanne 2015-2018 *[Summary report on state real estate management 2015-2018]*.

government amounts to 820,000 square metres.

and environmentally valuable and are located in Estonia. The Ministry of Foreign Affairs has real estate in other countries, but this is not addressed in the present renovation strategy. The floor area of government-owned buildings with climate control is 820,000 m^2. The majority of it is that of educational and research buildings, vocational schools accounting for the biggest part thereof. Of accommodation buildings, the majority are dormitories for students or pupils. Of commercial and service buildings, the majority are museums and sports buildings. Special-purpose buildings include internal security and defence forces buildings.

The majority of such buildings are schools and offices.



A quarter of the floor area of central-government property has at least class C energy performance.

Figure 15. Real estate owned by the central government, by floor area.

Eluhooned	Residential buildings
Laod	Warehouses
Tervishoid	Healthcare
Tööstus	Industry
Muud erihooned	Other special-purpose buildings
Kaubandus, teenindus	Commerce, services
Majutus	Accommodation
Büroo	Office
Haridus, teadus	Education, research

The State Real Estate Registry has energy performance certificate information on 49% of the floor area of central-government-owned buildings with climate control. Based on floor area, 25% of government-owned property, i.e. 200,000 m^2, with an energy performance certificate has been awarded class A, B or C.

In addition to the energy performance certificate data on the property owned by the central government, the State Real Estate Registry has information on the energy performance certificates of premises rented by

the central government. Such information is known regarding 81% of rented premises with climate control. Pursuant to the Energy Performance of Buildings Directive (2012/27/EU)[18], central governments should only buy or rent premises in buildings that meet at least the minimum energy performance requirements. Of the government-rented premises with climate control, 30%, i.e. 230,000 m^2, comply with energy class A, B or C. The biggest percentage of class A premises the central government rents is in the joint ministerial building at Suur-Ameerika 1, Tallinn.

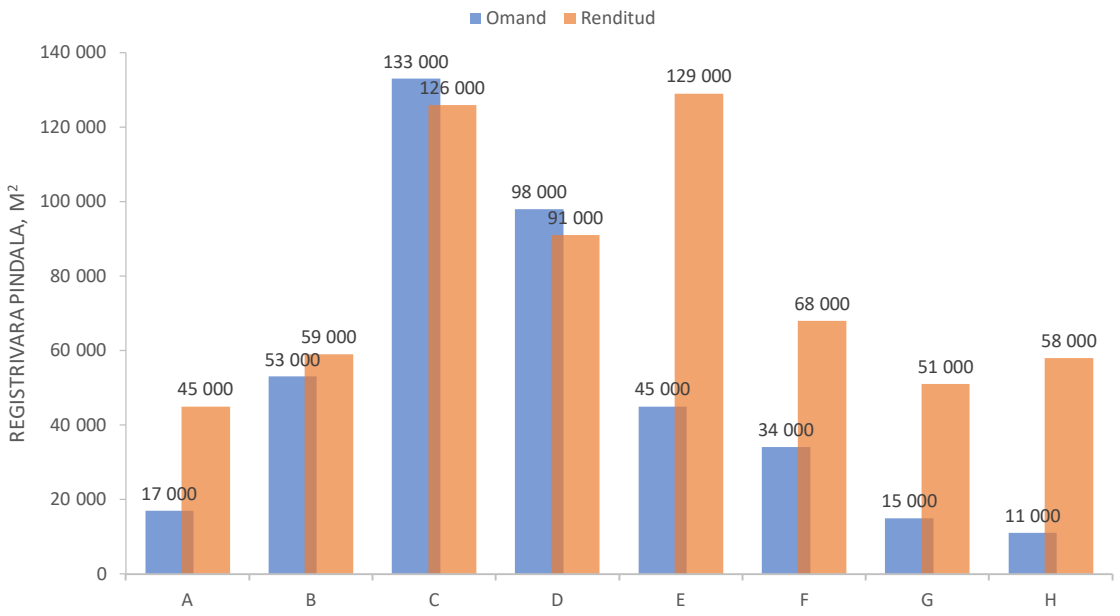


Figure 16. Premises that have an energy performance certificate and are used by the central government, by energy class.

Omand	Owned
Renditud	Rented
Registrivara pindala, m^2	Area of registered property, m^2

The State Real Estate Registry also has data on the state of repairs of the buildings: 5 – good, 4 – satisfactory, 3 – needing repairs, 2 – to be demolished. The accommodation and educational buildings have the best state of repairs. As the majority of the accommodation buildings are school dormitories, it can be inferred that so far, investments have been made mostly for educational buildings.

Table 13. Premises with climate control owned by the central government.

	OWNED PROPERTY IN TOTAL		IN GOOD STATE OF REPAIRS AND OF AT LEAST CLASS C		NEEDING RENOVATION	
	Quantity	Area of registered property, m^2	Quantity	Area of registered property, m^2	Quantity	Area of registered property, m^2
RESIDENTIAL BUILDINGS	257	40,100	4	400	253	39,700
OFFICE	104	70,100	1	2,200	103	67,900
ACCOMMODATION	106	108,100	14	37,700	92	70,400

[18] Directive 2012/27/EU of the European Parliament and of the Council. https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:32012L0027&from=EN.

COMMERCE AND SERVICES	64	29,900	7	7,700	57	22,200
EDUCATION, RESEARCH	109	318,600	21	115,500	88	203,100
HEALTHCARE	7	8,800	0	0	7	8,800
WAREHOUSES	102	19,200	0	0	102	19,200
INDUSTRY	14	6,100	0	0	14	6,100
OTHER SPECIAL-PURPOSE BUILDINGS	99	63,300	0	0	99	63,300
	862	**660,000**	**47**	**160,000**	**815**	**500,000**

In this renovation strategy, the property owned by the central government also includes 570,000 m^2 of premises with climate control the government rents from the State Real Estate Company. The biggest part of such rented premises are offices, special-purpose buildings (buildings of the Rescue Board, prisons) and educational buildings (upper secondary and vocational schools).

Table 14. Premises with climate control rented from State Real Estate Company.

	RENTED FROM STATE REAL ESTATE COMPANY		**IN GOOD STATE OF REPAIRS AND OF AT LEAST CLASS C**		**NEEDING RENOVATION**	
	Quantity	Area of registered property, m^2	Quantity	Area of registered property, m^2	Quantity	Area of registered property, m^2
RESIDENTIAL BUILDINGS	50	7,200	1	100	49	7,100
OFFICE	147	258,000	10	54,900	137	203,100
ACCOMMODATION	10	8,400	8	4,500	2	3,900
COMMERCE AND SERVICES	13	66,800	6	20,100	7	46,700
EDUCATION, RESEARCH	31	66,600	8	26,300	23	40,300
HEALTHCARE	5	3,800	1	600	4	3,200
WAREHOUSES	0	0	0	0	0	0
INDUSTRY	3	1,400	0	0	3	1,400
OTHER SPECIAL-PURPOSE BUILDINGS	110	158,700	19	57,800	91	100,900
	369	**570,000**	**53**	**160,000**	**316**	**410,000**

The buildings with climate control owned by local authorities have 5.3 million m^2 of floor area.

There is no separate database on municipal real estate. The data on municipal buildings comes from a report[19] issued by the National Audit Office in 2016. In 2015, municipalities used 6 300 buildings with the total floor area of 5.6 million square metres. Among others, these include ~5 000 buildings with climate control and the total floor area of 5.3 million m^2.

The majority of the municipal buildings with climate control are schools and nursery schools. Service buildings include libraries, local community centres, museums and sports buildings. Accommodation includes social housing and retirement homes.

[19] Riigikontroll „Ülevaade omavalitsuste hoonestatud kinnisvarast ja selle haldamisest“ *[National Audit Office. Overview of municipal real estate and its management]*. 2016.

The majority of such buildings are schools and nursery schools.

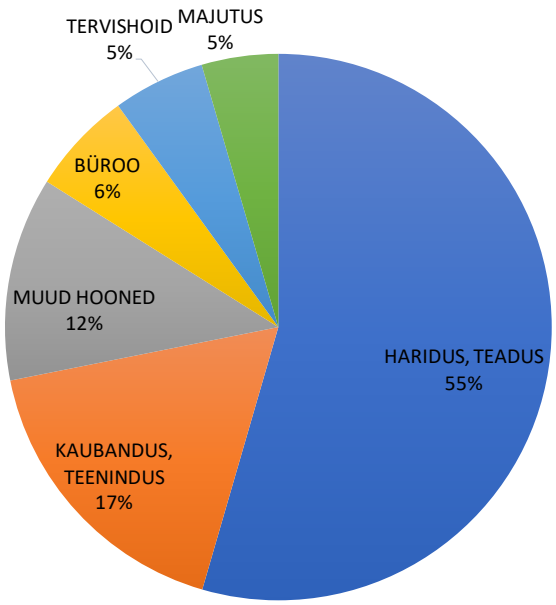


Figure 17. Distribution of real estate owned by municipalities, by floor area.

Tervishoid	Healthcare
Majutus	Accommodation
Büroo	Office
Muud honed	Other buildings
Kaubandus, teenindus	Commerce, services
Haridus, teadus	Education, research

Information on energy performance certificates is known about 1,600 municipal buildings, which account for 49% of the total floor area of municipal buildings with climate control. Based on floor area, 17% of municipal property, i.e. 900,000 m^2, with an energy performance certificate have been awarded class A, B or C.

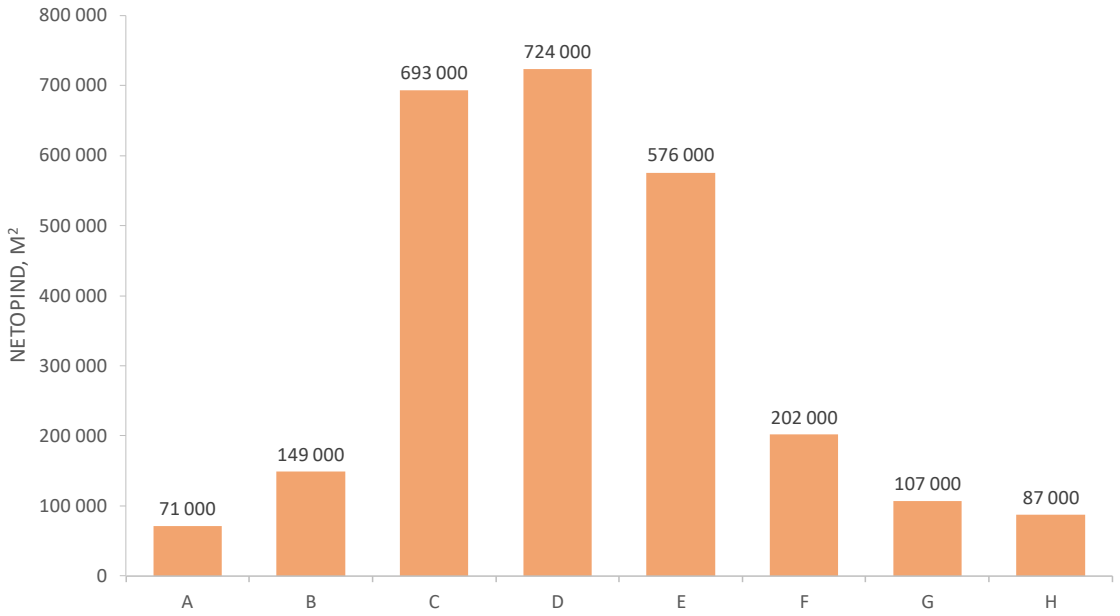


Figure 18. Municipal buildings with energy performance certificates, by energy class and floor area.

Netopind, m^2	Net area, m^2

Around 4 million square metres need renovation.

For the National Audit Office's report, municipalities assessed the state of repairs of their buildings on a 5-point scale: very good, good, satisfactory, poor, and very poor.

Municipal buildings estimated to be in a very good or good state of repairs and having at least energy class C are considered to not need renovation. The buildings in the best state of repairs are healthcare, educational and service buildings. Worse is the state of repairs of buildings municipalities classified under other buildings, i.e. mostly residential buildings, workshops and ancillary buildings.

10% of municipal buildings is estimated to fall out of use. Municipalities estimated that 90% of premises currently in use will also be in use after 5 years.

Table 15. State of repairs of municipal buildings.

	BUILDINGS IN USE		**IN GOOD STATE OF REPAIRS AND OF AT LEAST CLASS C**		**NEEDING RENOVATION**	
	Quantity	Net area, m^2	Quantity	Net area, m^2	Quantity	Net area, m^2
OFFICE	378	290,000	24	11,000	354	279,000
ACCOMMODATION	216	215,000	12	8,000	204	207,000
COMMERCE AND SERVICES	1,130	825,000	112	113,000	1,018	712,000
EDUCATION, RESEARCH	1,352	2,589,000	158	376,000	1,194	2,212,000
HEALTHCARE	138	258,000	13	53,000	125	205,000
OTHER BUILDINGS	847	476,000	36	49,000	811	427,000
	4,061	**4,700,000**	**355**	**610,000**	**3,706**	**4,000,000**

5.8 Private sector

There are 22 million square metres of private-sector non-residential buildings.

In the analysis of this strategy, private-sector non-residential buildings include such buildings with climate control, taken into use before 2000 (included) and not owned by the central government or municipality. The quantity of these buildings is 27,000, their total floor area being 22 million square metres. The biggest part of private-sector non-residential buildings are industrial buildings, warehouses, offices, commercial and services buildings.

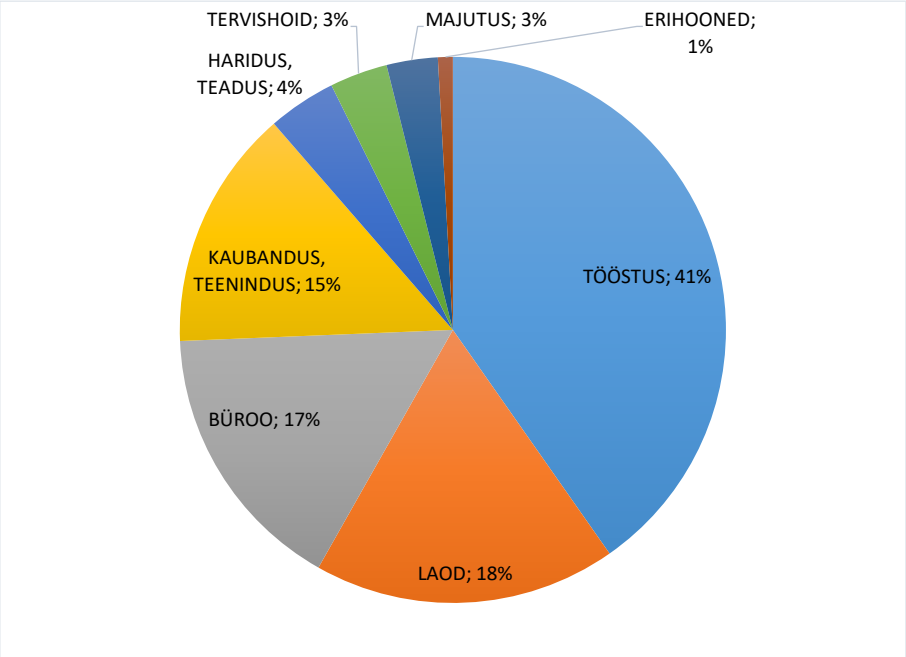


Figure 19. Private-sector non-residential buildings, by floor area.

Tervishoid	Healthcare
Majutus	Accommodation
Erihooned	Special-purpose buildings
Haridus, teadus	Education, research
Kaubandus, teenindus	Commerce, service
Tööstus	Industry
Büroo	Office
Laod	Warehouses

Table 16. Commercial property with climate control.

	Quantity of buildings		Net area, m²	
OFFICE	3,400	13%	3,680,000	17%
ACCOMMODATION	2,000	7%	690,000	3%
COMMERCE AND SERVICES	5,500	20%	3,250,000	15%
EDUCATION, RESEARCH	500	2%	920,000	4%
HEALTHCARE	400	1%	780,000	3%
WAREHOUSES	7,500	28%	4,080,000	18%
INDUSTRY	7,900	29%	9,170,000	41%
SPECIAL-PURPOSE BUILDINGS	500	2%	200,000	1%
	26,900		**22,300,000**	

5.9 Non-residential buildings falling out of use

It is estimated that up to 6 million m^2 of non-residential buildings might fall out of use.

The percentage of non-residential buildings to fall out of use is estimated to be of the same magnitude as for apartment buildings. In peripheries, up to 90% of non-residential buildings might fall out of use; in transitional areas, this indicator might be 80%; in the immediate hinterland, 30%, second-tier centres, 10%; and in functional region centres, 5%. Quantity-wise, up to 30% and area-wise, up to 20% of non-residential buildings are projected to fall out of use.

Table 17. Non-residential buildings estimated to fall out of use.

	Quantity of buildings	**Net floor area, m^2**
Centre of functional region	700	800,000
Second-tier centre	400	300,000
Immediate hinterland	1,900	1,100,000
Transitional area	3,700	2,100,000
Periphery	3,600	1,600,000
	10,300	**5,900,000**

5.10 Architectural monuments and buildings of cultural and environmental value

Pursuant to the Building Code, the minimum energy performance requirements do not apply to buildings that have been declared to be architectural monuments, that are used primarily for religious purposes and that are of cultural and environmental value. Nevertheless, the number and floor area of buildings mentioned in this strategy partially include architectural monuments and buildings of cultural and environmental value. The scope of this strategy excludes buildings that, according to the Building Registry, are defined as cult or sacramental buildings and according to the State Real Estate Registry, as heritage or buildings of the cultural and environmental value belonging to the central government.

The number of architectural monuments is 5276[20], i.e. 2% of the total number of buildings covered by this strategy (~210,000). There is no central registry for buildings of the cultural and environmental value. A built-up area of the cultural and environmental value is an area

[20] National Heritage Board. National Registry of Cultural Monuments. https://register.muinas.ee/public.php?menuID=statistic.

determined by local authorities in the zoning plan, and special renovation requirements apply there. The renovation requirements are more detailed for very valuable and valuable buildings; for less valuable buildings, the renovation requirements are not very restrictive.

Architectural monuments and buildings of cultural and environmental value also need to be renovated, but often it is not possible or reasonable to strive for energy class C. Thus, there could be separate measures for the renovation of architectural monuments and buildings of cultural and environmental value. These could include lower energy performance targets than class C in this renovation strategy. The renovation analysis of wooden apartment buildings of environmental value[21] indicated that it is possible to achieve 20%-30% energy savings in such buildings if just smaller works aimed at saving energy are carried out.

6 Renovation practices so far

6.1 Renovation of private houses

Renovation work is done in around 500 to 700 private houses a year.

The database of Statistics Estonia shows the total amount of renovation-related building permits and notices as renovation-related building permits. The data on use permits also reflects the total of renovation-related use permits and notices. According to Statistics Estonia[22], the renovation of private houses has been increasing between 2011 and 2018. In the last five years, renovation-related building permits/notices have been issued for 610 and use permits/notices for 300 private houses per year on average.

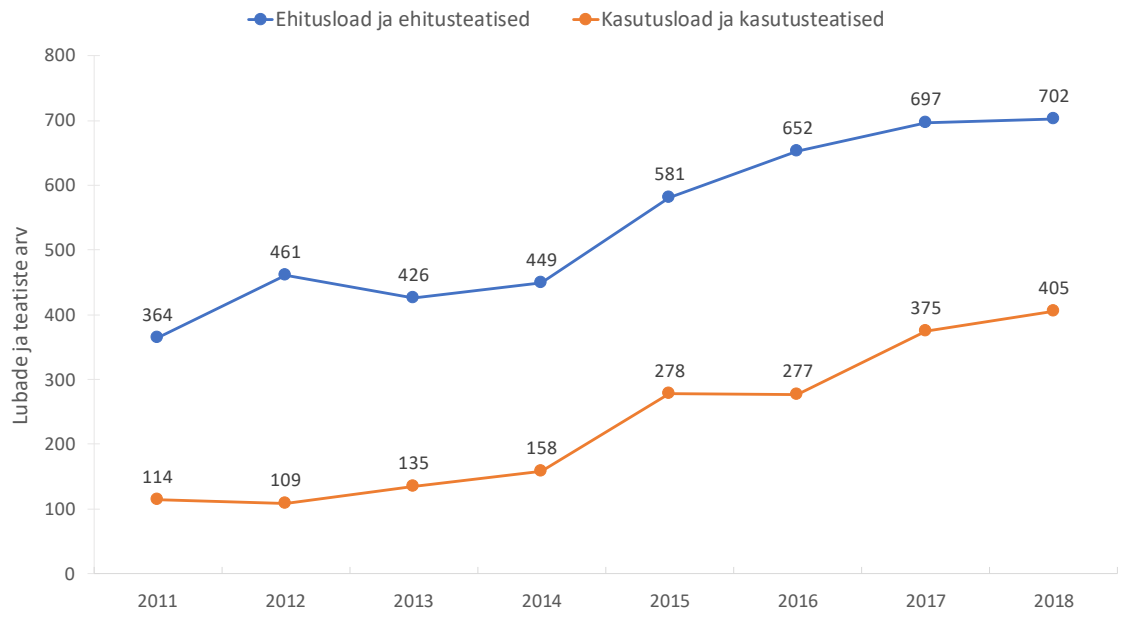


Figure 20. Building permits/notices and use permits/notices for the renovation of private houses.

[21] Arumägi, Endrik. Renovation of Historic Wooden Apartment Buildings. 2015. https://digikogu.taltech.ee/et/Item/da192f05-1fd6-4079-92e5-4c69ef74df43.

[22] Statistics Estonia. Table EH045: Granted building permits and completed dwellings by type of construction, county and type of residential building (quarters).

Ehitusload ja ehitusteatised	Building permits and building notices
Kasutusload ja kasutusteatised	Use permits and use notices
Lubade ja teatiste arv	Number of permits and notices

The number of actual renovations of private houses is likely to be of the same magnitude as the number of building permits/notices because not all owners submit a building notice and not all those who have submitted it will renovate. The volume of renovations not recorded in the Building Registry could be considerable in the recent decade, but the amount of unrecorded work should diminish as the national building data is being digitised. Around 500 to 700 private houses are estimated to be renovated each year. The recent five-year average net area of private houses with building permits/notices for renovation is 86,000 m^2, i.e. 0.4%, and that of private houses with renovation-related use permits/notices is 52,000 m^2, i.e. 0.3% of the area of private houses taken into use before 2000.

According to the Building Registry, 39% of building permits for private house renovation have covered the whole house, which means that the total floor area fully renovated each year is 35,000 square metres. The average annual area that needs to be renovated to achieve the target specified in this strategy is 470,000 square metres, i.e. ~13 times bigger than it is estimated to be today.

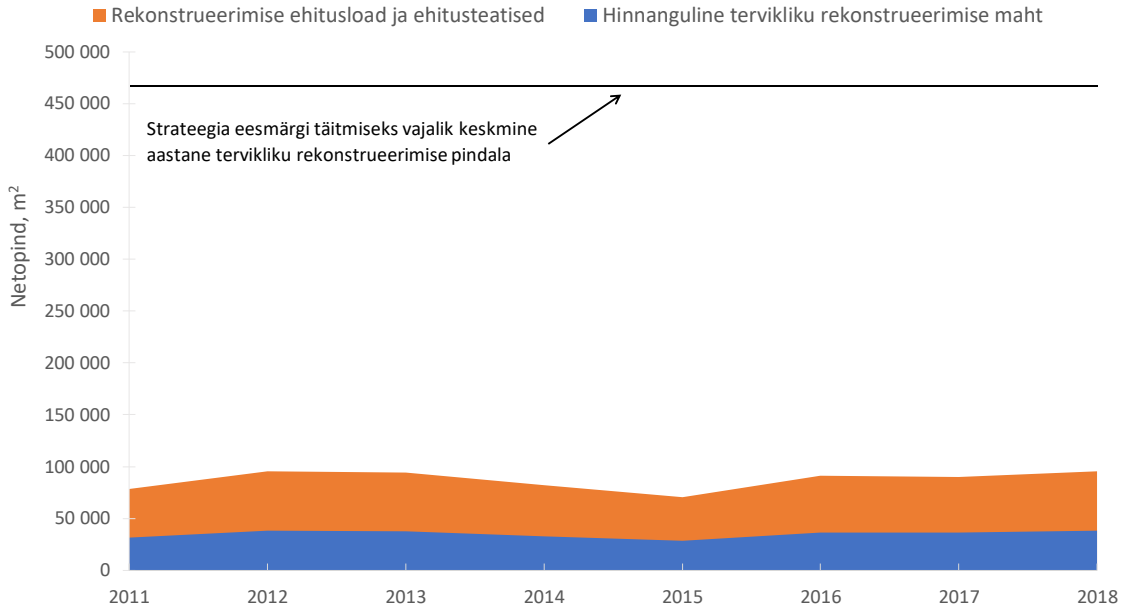


Figure 21. Building permits/notices for private house renovations, by net area.

Rekonstrueerimise ehitusload ja ehitusteatised	Building permits and building notices for renovation
Hinnanguline tervikliku rekonstrueerimise maht	Estimated volume of full renovation
Strateegia eesmärgi täitmiseks vajalik keskmine aastane tervikliku rekonstrueerimise pindala	Average annual full renovation area required for fulfilling the purpose of the strategy
Netopind, m^2	Net area, m^2

The long-term strategy for renovation requires renovation to achieve at least energy class C. For private houses, this means:

- insulation of outer walls (e.g. 15–20 cm of mineral wool);
- insulation of the roof or attic (e.g. 20–30 cm of mineral wool);
- replacement of windows (triple-glazed);
- modernisation of the heating system (geothermal or air-water heat pump, pellet boiler, etc.);
- installation of a ventilation system with heat recovery (a ventilation unit with supply and extract piping).

The renovation volumes of private houses with use permits/notices received after renovation are not known, but it could be presumed that a large part of renovated private houses does not reach energy class C because, usually, this is not the aim of the owner. Instead, renovations are done step by step, as financial resources allow.

6.2 Renovation of private houses with the help of financial aid

With the measure of financial aid for increasing energy performance of small residential buildings[23], aid has been given for the renovation of more than 500 private houses since October 2016. The aid has been granted for energy-saving improvements. The aid covers 30% of eligible costs, and the maximum amount of aid for one private house is €15,000. With the example of the terms and conditions of the measure, which were reviewed in the spring of 2020, it is possible to regionally adjust the scope of the renovation as well as the share and size of the aid, to address the financing market failures.

Aid requests cover mainly isolated energy-saving improvements, such as heating system replacement, building envelope insulation and installation of solar panels for local electricity generation.

Private houses are not renovated just to save energy. There are other reasons for the renovation. For example, to install a more comfortable heating system (heat pumps instead of stoves). A full renovation also might include work to increase the size of the living area (the attic is taken into use).

Renovation support for private houses is evenly distributed among regions. Aid requests have been received from all counties.

[23] https://kredex.ee/en/services/elamistingimuste-parandamiseks/private-home-renovation-support.

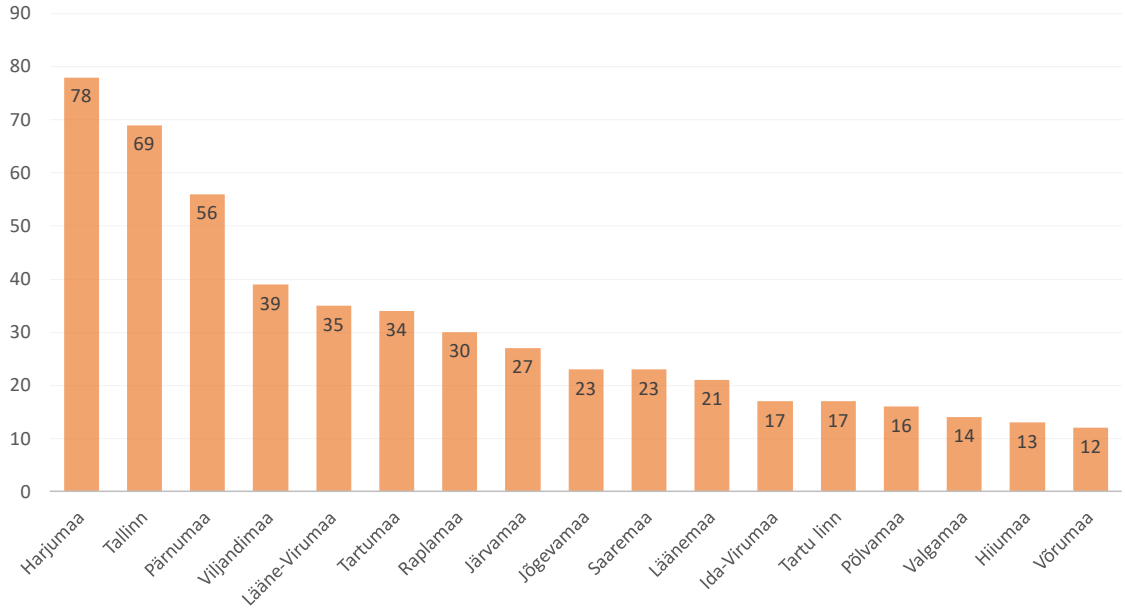


Figure 22. Distribution of renovation support requests regarding private houses, November 2019.

Harjumaa	Harju County
Tallinn	Tallinn
Pärnumaa	Pärnu County
Viljandimaa	Viljandi County
Lääne-Virumaa	Lääne-Viru County
Tartumaa	Tartu County
Raplamaa	Rapla County
Järvamaa	Järva County
Jõgevamaa	Jõgeva County
Saaremaa	Saare County
Läänemaa	Lääne County
Ida-Virumaa	Ida-Viru County
Tartu linn	Tartu city
Põlvamaa	Põlva County
Valgamaa	Valga County
Hiiumaa	Hiiu County
Võrumaa	Võru County

6.3 Renovation of apartment buildings

Around 400 apartment buildings are renovated a year.

The number of renovations of apartment buildings has increased too.[24] In the last five years, renovation-related building permits/notices have been issued for 880 and use permits/notices for 380 private houses per year on average. Around 400 apartment buildings are renovated a year.

[24] Statistics Estonia. Table EH045: Granted building permits and completed dwellings by type of construction, county and type of residential building (quarters).

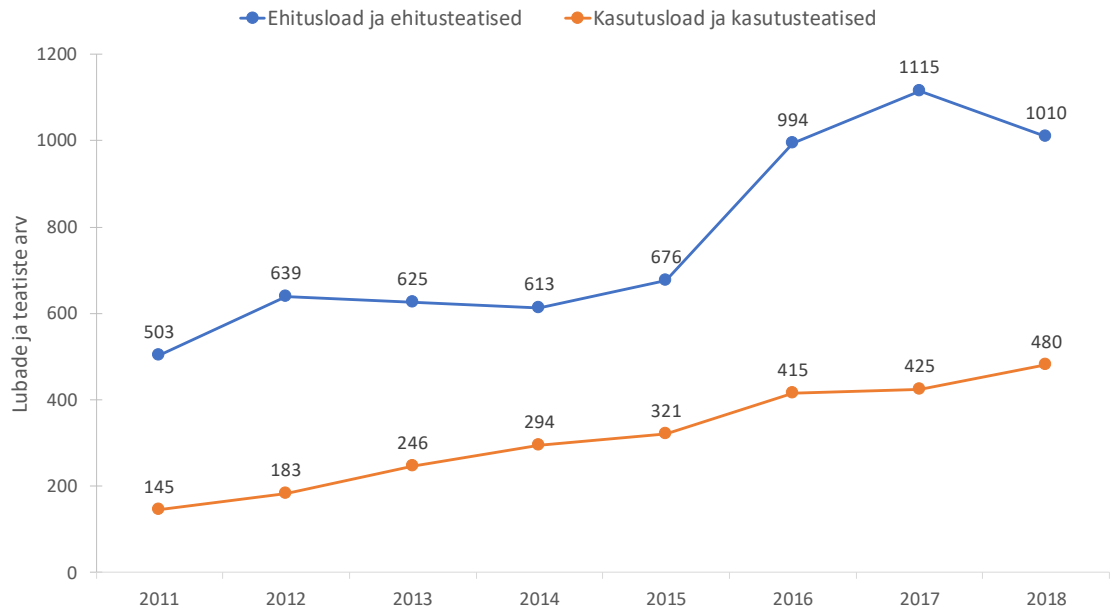


Figure 23. Renovation-related building and use permits of apartment buildings.

Ehitusload ja ehitusteatised	Building permits and building notices
Kasutusload ja kasutusteatised	Use permits and use notices
Lubade ja teatiste arv	Number of permits and notices

Use permits/notices are obtained after renovation regarding 1.3 M m^2 of apartment buildings, i.e. 4% of the floor area of apartment buildings taken into use before 2000. If to presume that full renovation is mainly done with the help of support, the average net area of apartment buildings that have been fully renovated between 2011 and 2018 amounts to 280,000 m^2, i.e. 1% of the area of apartment buildings taken into use before 2000. The average annual area that needs to be renovated to achieve the target specified in this strategy is ~600,000 square metres, i.e. ~2 times bigger than it is estimated to be today. Thus, there is no need to increase the number of apartment buildings that are renovated; instead, the percentage of a full renovation should be increased.

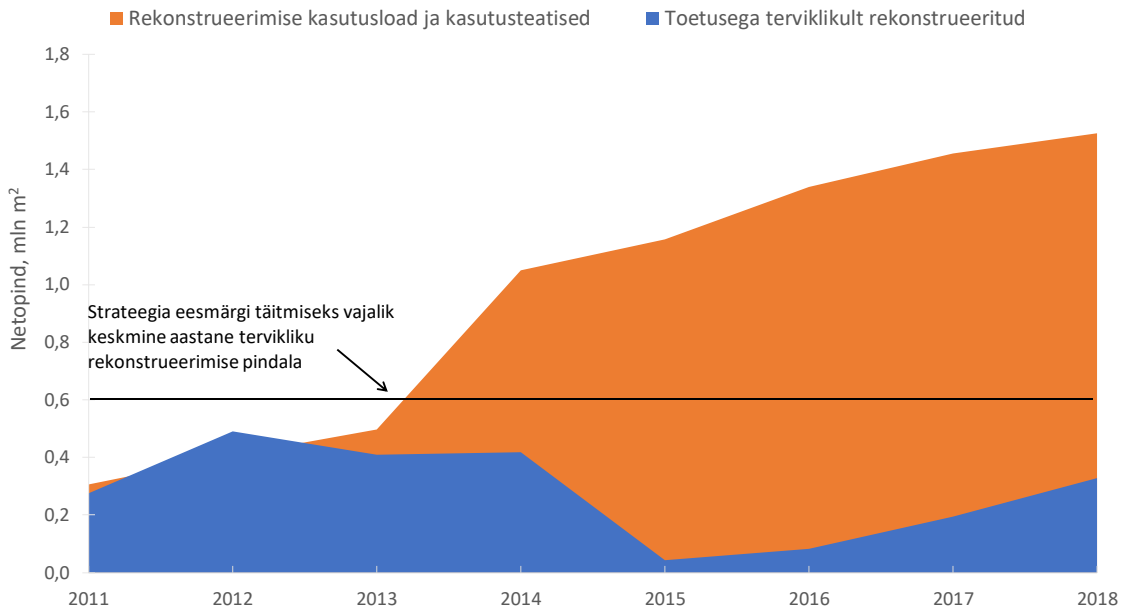


Figure 24. Renovation-related use permits/notices of apartment buildings, by net area.

Rekonstrueerimise kasutusload ja kasutusteatised	Use permits and use notices for renovation
Toetusega terviklikult rekonstrueeritud	Fully renovated with support
Netopind, m^2	Net area, m^2
Strateegia eesmärgi täitmiseks vajalik keskmine aastane tervikliku rekonstrueerimise pindala	Average annual full renovation area required for fulfilling the purpose of the strategy

The long-term strategy for renovation requires renovation to achieve at least energy class C. For apartment buildings, this means:

- insulation of outer walls (e.g. 15–20 cm of mineral wool);
- insulation of the roof or attic (e.g. 30–40 cm of insulation);
- replacement of windows (triple-glazed);
- replacement of the heating system (for district heating, the installation of a new two-pipe system with thermostatic valves on radiators);
- installation of a ventilation system with heat recovery (either a central unit with pipelines within wall insulation or an extraction heat pump).

The volume of renovation done on apartment buildings that have received a use permit/notice after renovation is not known, but it may be presumed that not all of these achieve energy class C. However, the apartment associations have incurred renovation costs or taken out loans for bigger work, and it is likely that in the near future, they will not launch another renovation.

6.4 Renovation of apartment buildings with the help of support

1,100 apartment buildings have been renovated with the help of support since 2010.

Apartment building renovation support[25] has been granted to 453 buildings with a total area of 1.2 million square metres since April 2015. As part of the support measure[26] implemented between 2010–2014, 661 apartment buildings with a total area of 1,6 M m^2 were renovated. A total of 1,114 apartment buildings have received a positive decision to their support request. The average is 110 apartment buildings a year.

Support rates depend on the energy class achieved and the location of the building. In Tallinn and Tartu, the support rate is 30%. In other cities where apartment values exceed €500 per square metre (mostly county centres), the support rate is 40%. In regions where the average apartment value is below €500 per m^2, the rate is 50%.

To receive the bigger support rate, energy class C must be achieved. For that purpose, the building envelope must be insulated, old windows must be replaced, the heating system must be renovated and a ventilation system with heat recovery must be installed.

Pursuant to the terms and conditions of the support, new technical solutions for renovating apartment buildings have been taken into use. Mechanical ventilation systems with heat recovery have become the norm. In addition, windows are placed into the insulation layer to eliminate the cold bridge between windows and external walls. Also, solar panels are installed for local electricity generation, although this is not required to receive the support. Also, guidance material has been compiled regarding the technical solutions for renovation.[27]

Figure 25. Ventilation pipelines in the external wall insulation, wooden frames to take windows in between the insulation layer (left) and PV panels (right).

Outside Tallinn and Tartu, it is possible to request a 10% lower support rate. Then there is no heat recovery requirement for the ventilation

[25] Korterelamute rekonstrueerimise toetuse andmise tingimused ja kord *[Terms, conditions and procedure for granting renovation support for apartment buildings]*. https://www.riigiteataja.ee/akt/126042019007.
[26] Rohelise investeerimisskeemi „Korterelamute rekonstrueerimise toetus" kasutamise tingimused ja kord *[Terms, conditions and procedure for using the green investment scheme 'Renovation support for apartment buildings']*. https://www.riigiteataja.ee/akt/110022015002.
[27] SA KredEx. Korterelamute välispiirete lisasoojustamise sõlmejoonised ja tüüpkorterite ventilatsioonilahendused *[Drawings of junctions for additional insulation of apartment buildings and ventilation solutions for standard apartments]*. https://kredex.ee/en/increasing-awareness-energy-performance/energy-performance-existing-buildings.

system and energy class D is acceptable. More than 90% of applications were for the higher support rate, which means they aimed for class C. In the event of a full renovation, other important work that does not provide energy saving but is necessary for the safe use of the building is done as well. This includes the renovation of balconies, electrical systems, water supply and sanitation systems.

Between 2010 and 2014, the support measure for apartment buildings helped save 60 GWh of heating energy a year[28]. This equals the annual district heat consumption of the city of Haapsalu. The presumable annual energy savings made with the help of the 2015-2019 support measure for apartment buildings are around 80 GWh. On average, the renovation of an apartment building usually results in ~55% of heat savings and 5% greater electricity consumption.

The problem with the renovation support for apartment buildings is that its financing is unstable. When the support measure opens, the number of applications is lower (in 2010 and 2015). In the next couple of years, the number of applications increases until the budget for the measure runs out. More stable financing would prevent renovation volumes from heaping up and the resulting price increases.

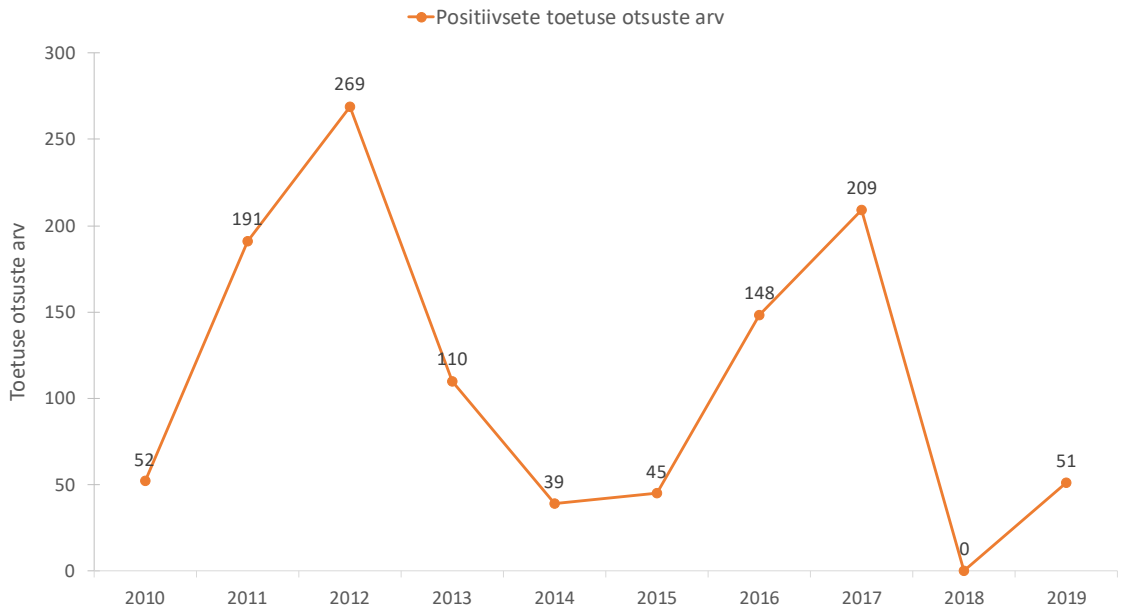


Figure 26. The number of successful support applications regarding the renovation of apartment buildings.

Positiivsete toetuse otsuste arv	Number of positive support decisions
Toetuse otsuste arv	Number of support decisions

Successfully renovated apartment buildings in the neighbourhood have an important influence on

The rate of applying for renovation support for apartment buildings varies by regions. Harju, Tartu and Lääne-Viru Counties are much more active than others. The experience with the renovation measures for apartment buildings has indicated that new renovations are often near previously renovated apartment buildings. Renovations in the

[28] SA KredEx. Korterelamute renoveerimisturu ülevaade ja perioodi 2010-2014 korterelamute rekonstrueerimistoetuse mõju analüüs *[Overview of apartment building renovation market and impact analysis of the renovation support measure for apartment buildings between 2010 and 2014]*.

the launch of new renovations.

neighbourhood are an incentive for other apartment associations to start renovating as well. In addition, there are already several technical consultants in the region who have helped apartment associations with their renovation. Their experience is valuable for other apartment associations during their renovation process.

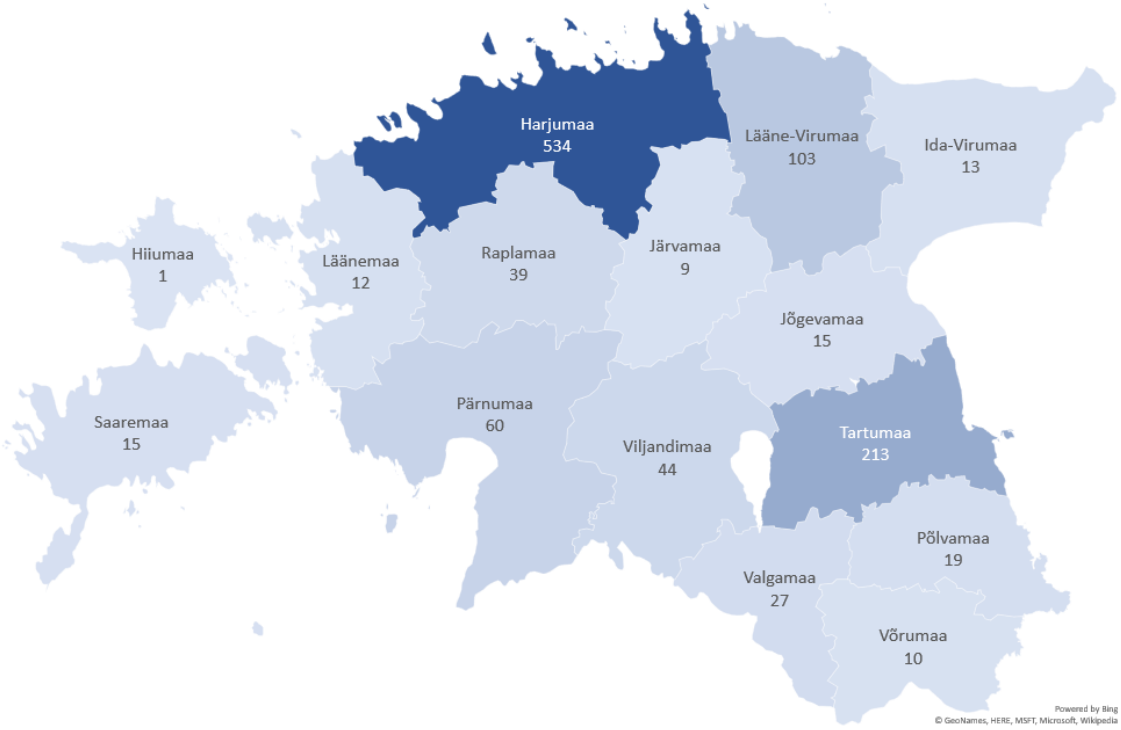


Figure 27. The number of successful support applications regarding the renovation of apartment buildings, by counties.

Hiiumaa	Hiiu County
Saaremaa	Saare County
Läänemaa	Lääne County
Harjumaa	Harju County
Lääne-Virumaa	Lääne-Viru County
Ida-Virumaa	Ida-Viru County
Raplamaa	Rapla County
Järvamaa	Järva County
Jõgevamaa	Jõgeva County
Pärnumaa	Pärnu County
Viljandimaa	Viljandi County
Tartumaa	Tartu County
Valgamaa	Valga County
Põlvamaa	Põlva County
Võrumaa	Võru County

6.5 Renovation of non-residential buildings

The number of renovation-related use permits/notices[29] for non-residential buildings has been relatively similar throughout the years. The sharp increase in the number in 2012 was caused by the renovation programme for public-sector buildings, which was financed from the proceeds from the sales of emission allowances.

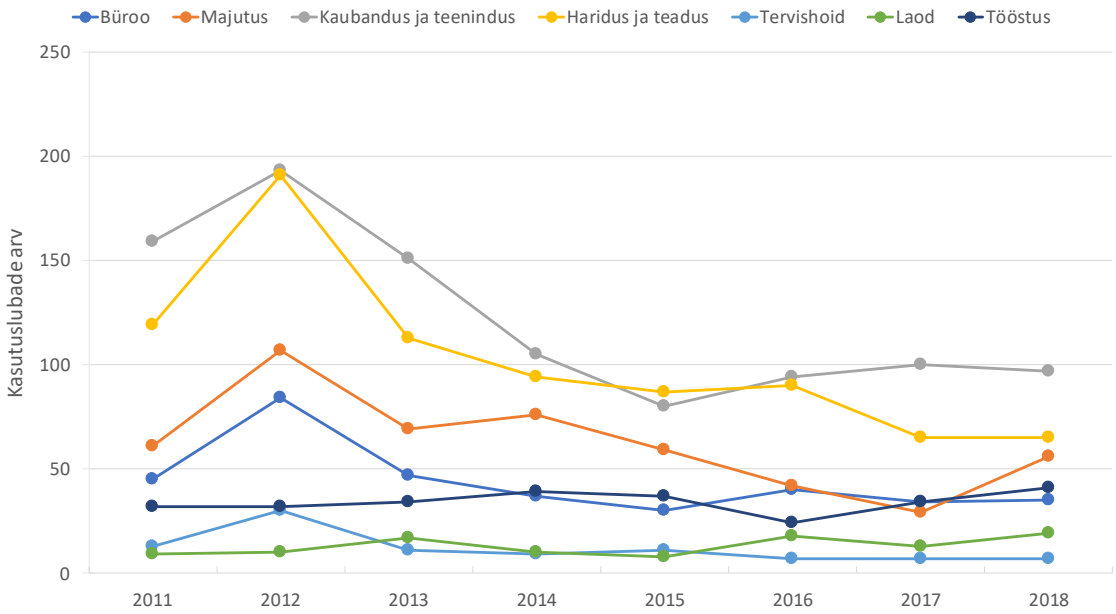


Figure 28. Renovation-related use permits/notices of non-residential buildings.

Büroo	Office
Majutus	Accommodation
Kaubandus ja teenindus	Commerce and service
Haridus ja teadus	Education and research
Tervishoid	Healthcare
Laod	Warehouses
Tööstus	Industry
Kasutuslubade arv	Number of use permits

Around 300 non-residential buildings are renovated each year.

On average, 320 use permits/notices for the renovation of non-residential buildings have been granted in the recent five years. The annual average net area of non-residential buildings with renovation-related use permits/notices is 860,000 m^2, i.e. 3% of the area of non-residential buildings taken into use before 2000. According to the Building Registry, 21% of building permits for the renovation of non-residential buildings have covered the whole building in the recent three years, which means that the total floor area fully renovated each year is around 170,000 square metres. The average area that needs to be renovated each year to achieve the target specified in this strategy is ~730,000 square metres, i.e. ~4 times bigger than it is estimated to be today. Thus, there is no need to increase the number of non-

[29] Statistics Estonia. EH046: Granted building permits and completed non-residential buildings by type of construction, county and type of buildings (quarters).

residential buildings that are renovated; instead, the percentage of a full renovation should be increased.

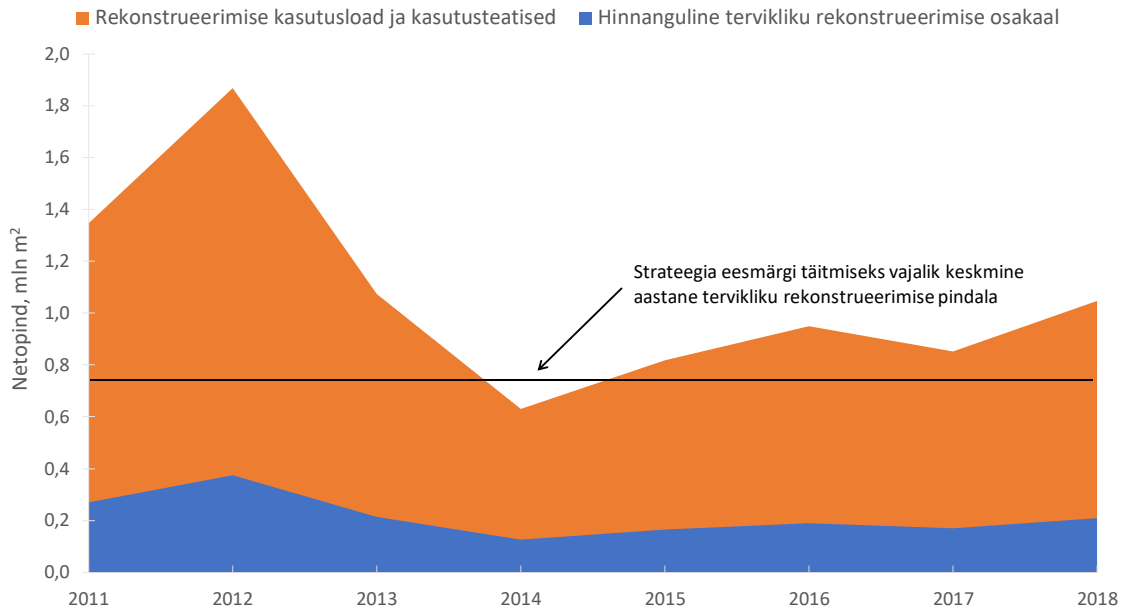


Figure 29. Renovation-related use permits/notices of non-residential buildings with climate control, by net area.

Rekonstrueerimise kasutusload ja kasutusteatised	Use permits and use notices for renovation
Hinnanguline tervikliku rekonstrueerimise osakaal	Estimated share of full renovations
Netopind, mln m^2	Net area, M m^2
Strateegia eesmärgi täitmiseks vajalik keskmine aastane tervikliku rekonstrueerimise pindala	Average annual full renovation area required for fulfilling the purpose of the strategy

Each year, the central government must renovate 3% of the area of their buildings.

The Energy Performance of Buildings Directive applies to the buildings of the central government and stipulates an obligation for them to renovate each year at least 3% of buildings that have over 250 square metres of useful floor area and do not comply with the minimum requirements so that these meet the minimum requirements afterwards. Estonia has honoured the 3% obligation.[30] On average, more than 4% of buildings covered by the obligation have been made compliant with the minimum requirements between 2015 and 2018. To meet the 3% obligation, it is necessary to renovate around 25,000 m^2 a year. The majority of the buildings made compliant with the requirements belong to the State Real Estate Company Riigi Kinnisvara AS.

The analysis of renovations made on private-sector non-residential buildings, as made for this strategy, indicated that the renovations do not result in energy class C. People mostly make easier and faster energy-saving improvements that do not hinder the use of the building during the work and that are paid off in 5 to 7 years. A full renovation

[30] Ministry of Finance. Riigi kinnisvara valitsemise koondaruanne 2015-2018 *[Summary report on state real estate management 2015-2018]*.

that includes insulation of the building envelope usually has too long a pay-off period for commercial property owners.

6.6 Renovation cost

The renovation cost data is based on the period from 2015 to 2019.

The average cost of a full renovation of a private house is around €400/m^2.

The renovation cost data regarding **private houses** are based on the information on the respective support measure between 2016 and 2019. The analysis of support requests covered a selection of applications that covered insulation of the building envelope, replacement of windows, replacement of the heating system and installation of a new ventilation system. The cost of the full renovation was between €210 and €560 per square metre (VAT included). The average full-renovation cost was €360 per square metre of a private house. The renovations made by the owner cost less. The average cost of renovations made at least partially by the owner was €297 per square metre. The average cost of private-house renovations done by construction companies was €397 per square metre. For this strategy, the estimated full-renovation cost of a private house is €400/m^2, presuming that most private-house owners will not renovate themselves. Thus, the renovation cost of a medium-sized private house (150 m^2) is around €60,000.

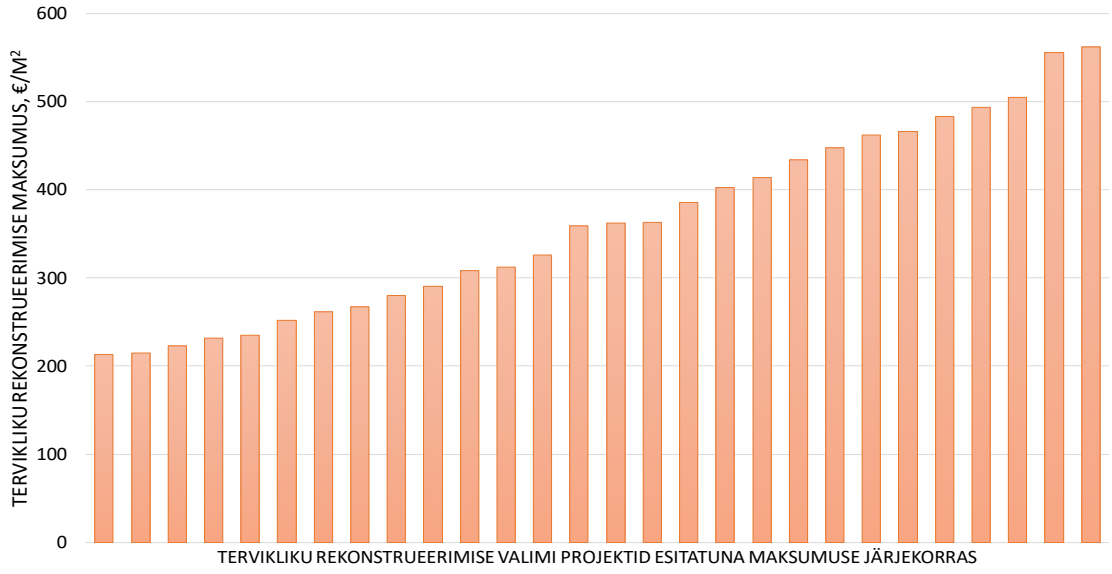


Figure 30. Full-renovation cost of private houses per metre of net area.

Tervikliku rekonstrueerimise maksumus, €/m^2	Cost of full renovation €/m^2
Tervikliku rekonstrueerimise valimi projektid esitatuna maksumuse järjekorras	Projects of the full renovation sample in the order of cost

The average cost of the full renovation of an

The cost data regarding the renovation of **apartment buildings** is based on the information on the respective support measure. The average full-renovation cost of apartment buildings that received support between 2015 and 2017 is €285 per square metre (VAT included). Apartment buildings where some of the energy-saving improvements

apartment building is around €300/m^2.

have already been done earlier (e.g. the heating system has been renovated) and those with the larger net area have lower renovation costs. Renovation of smaller apartment buildings (fewer than 10 apartments) and those of the cultural and environmental value costs more. The average apartment building that has applied for full-renovation support has 2,600 m^2 of net area (40 apartments), which means that the average cost of a full renovation of one building is ~€800,000.

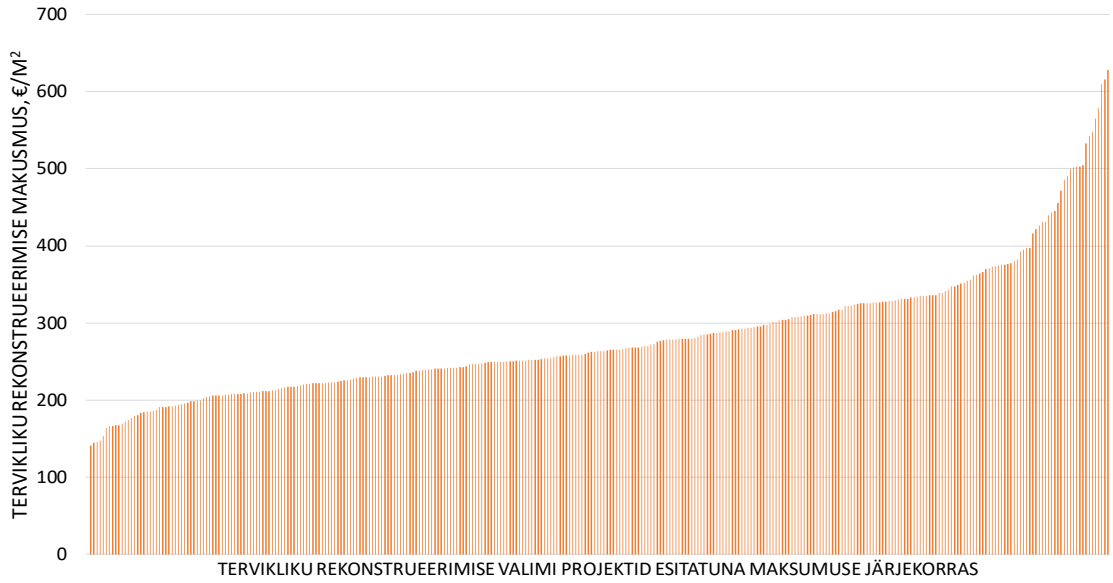


Figure 31. Full-renovation cost of apartment buildings per metre of net area.

Tervikliku rekonstrueerimise maksumus, €/m^2	Cost of full renovation, €/m^2
Tervikliku rekonstrueerimise valimi projektid esitatuna maksumuse järjekorras	Projects of the full renovation sample in the order of cost

The data on the apartment-building renovation measure shows that the increasing numbers of renovations are accompanied by increasing costs. In addition to the increased demand, the cost increases are the result of the increased renovation volumes ordered by apartment associations. After gaining more experience with renovating, the measure will cover more apartment buildings that, besides required improvements, make other improvements needed for the functioning of the building, such as replacement of the electrical, water and sanitation systems, installation of solar panels, construction of new balconies to replace the old ones, etc. For this strategy, the full-renovation cost of an apartment building is estimated to be €300/m^2.

Table 18. Apartment building renovation cost dynamics.

	Full renovation applications	Renovation cost, €/m²	
		Average	Median
2015	30	249	230
2016	124	264	251
2017	173	300	287

The renovation cost of **public-sector buildings** is based on the data of the 2019 support measure for energy performance of central-government buildings. The renovation costs are between €700 and

€2,000 per square metre (VAT included). Projects with higher renovation costs also include building extensions. The average renovation cost, extensions excluded, is around €1,100/m^2, whereas the energy-saving improvements account for ~€600/m^2 of it. The cost of energy-saving improvements made during the renovation and that of other improvements are shown in the table below.

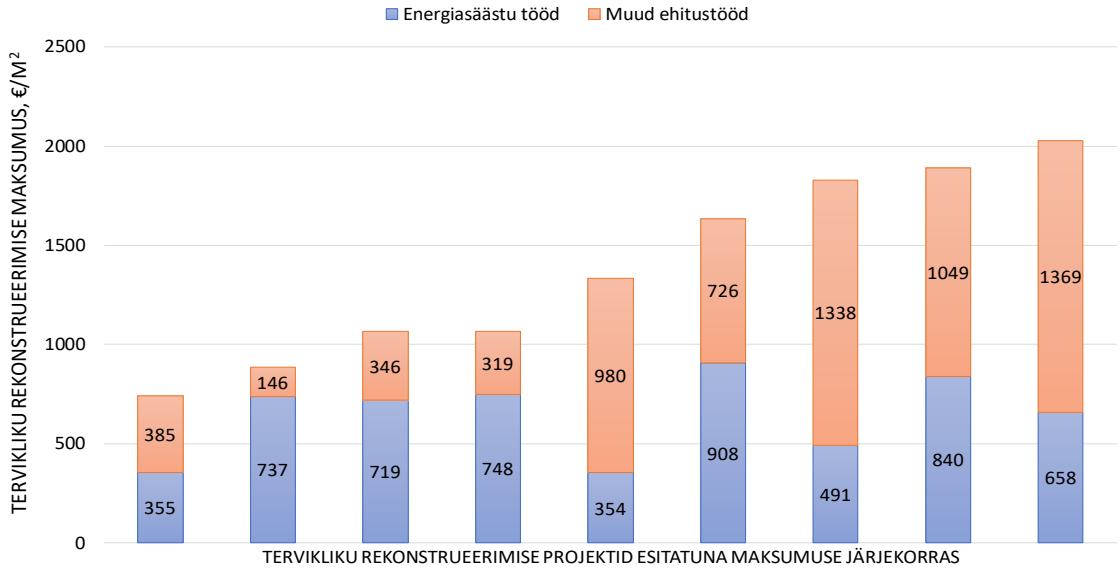


Figure 32. Full-renovation cost of public-sector buildings per metre of net area.

Energiasäästu tööd	Energy saving work
Muud ehitustööd	Other construction work
Tervikliku rekonstrueerimise maksumus, €/m^2	Cost of full renovation, €/m^2
Tervikliku rekonstrueerimise projektid esitatuna maksumuse järjekorras	Projects of the full renovation sample in the order of cost

The renovation costs of **private-sector non-residential buildings** have been calculated on the basis of the analysis of such work. In private-sector buildings (mostly offices, commercial and service buildings), energy savings are the most cost-effectively achievable by replacing the building services systems. On market terms, so far, mostly just smaller work costing €10 to €20 per m^2 has been done.

Table 19. Energy performance improvement measures for non-residential buildings.

System/structural part	Minimum renovation	Maximum renovation	Cost, €/m^2
Building automation	Upgrade/adjustment of the system	System replacement/creating a new system	2-25
Ventilation	Ventilation unit replacement and configuration	Replacement of the unit and system with a new unit and system, increasing functionality, needs-based management, etc. or installing the system if the building did not previously have climate control	15-60
Illumination	Replacement of fluorescent tubes with LED tubes	Replacement of the illumination of the whole building with LED lamps and needs-based management	5-30
Heating system	Balancing of the system, replacement of the heat source	Creating a new comprehensive system and/or replacement of the heat source	5-30

Cooling system	Balancing of the system, replacement of the cooling unit	Creating a new comprehensive system or adding one if the building did not previously have climate control	15-35
Monitoring	Measurement of the actual consumption	Measurement of the actual consumption, establishing a web-based cost calculation system, monitoring/analysis	1-10
Commercial cooling systems[31]	Using residual heat, fitting refrigerators with doors	Creating a new comprehensive system	15-50
Window/glass facade	Sun control film installation	Window or glass facade replacement	5-50

A full renovation of a commercial property costs around €200/m^2 if only the building services systems are upgraded and around 600 €/m^2 if the building envelope is also upgraded.

In buildings where upgrading the building services system is sufficient for achieving energy class C, renovation work costs around €200/^{2} (VAT included). Upgrading the building services system is sufficient in buildings where electricity accounts for the majority of energy consumption. For example, offices and service buildings where illumination, appliances, cooling and ventilation account for the majority of energy consumption.

In buildings where heating accounts for the majority of energy consumption, the building envelope must also be insulated and windows replaced in order to achieve energy class C. These include schools, nursery schools, hospitals and accommodation establishments. In the case of buildings whose building envelopes also require upgrading during renovation, the cost of work related to energy savings in public sector building renovations of €600/m^2 is considered as the cost of renovation.

Office buildings and commercial buildings form 1/3 of the floor area of private sector non-residential buildings. The average renovation cost of private sector non-residential buildings calculated in the strategy is $0.33 \times 200 + 0.67 \times 600 = €450/m^2$.

The cost of demolishing disused buildings is around €50/m^2.

Building demolition costs are based on the local government support measure, the purpose of which is to demolish residential buildings and non-residential buildings that have fallen out of use. The cost of demolition has ranged from €10 to €140/m^2 (VAT included). The cost of demolition per square metre of the net area is higher in the case of small buildings (under 100 m^2). The average demolition cost is €43/m^2. The strategy considers €50/m^2 as the cost of demolition.

[31] In the energy performance calculation methodology, cooling systems are process energy, which is not taken into account in the building's energy performance, but those used in commerce are large energy-intensive systems.

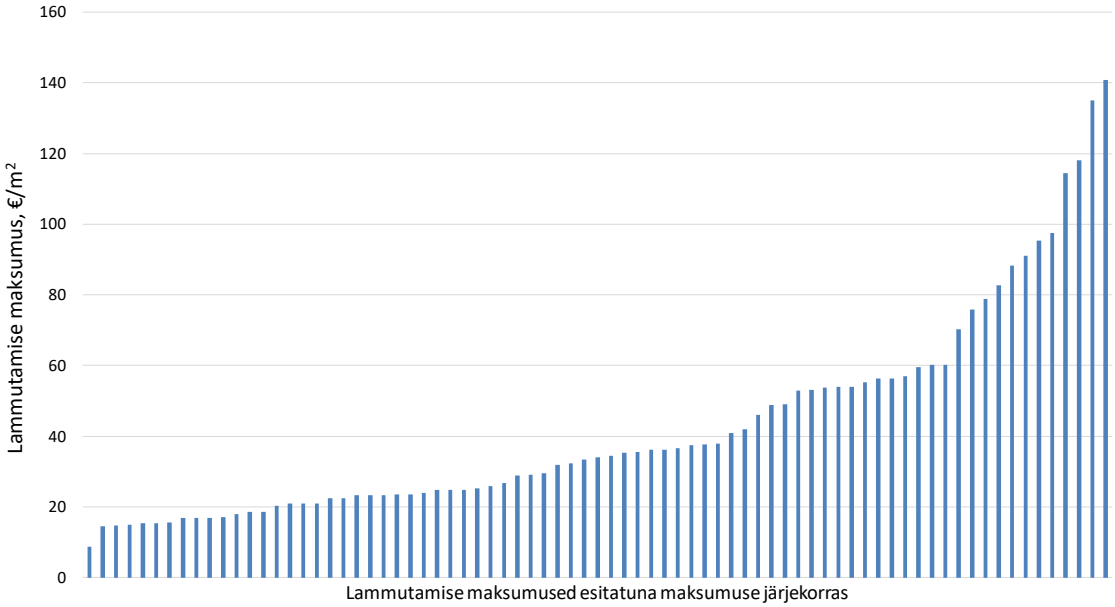


Figure 33. The cost of demolishing disused buildings per square metre of net area.

Lammutamise maksumus, €/m²	Cost of demolition, €/m²
Lammutamise maksumused esitatuna maksumuse järjekorras	Costs of demolition in the order of cost

6.7 Energy savings achieved by renovation

Full renovation of buildings can lead to heat energy savings of around 50% on average. Renovation may increase electricity use in buildings that did not previously have mechanical ventilation systems (private houses, apartment buildings and educational buildings), because the building services systems required for climate control consume electricity. Renovation reduces the use of electricity in office buildings and commercial and service buildings where electricity accounted for the majority of energy consumption also before renovation. The use of primary energy is reduced by 32% on average.

The values of heating, electricity and weighted specific energy use (the so-called WSEU label that is based on measured consumption data) are presented in the table below. The values are given for two heat sources: efficient district heating (weighting factor 0.65) and natural gas (weighting factor 1.0). The electricity weighting factor is 2.0.

Private houses differ from other building types, as in this case, stove heating is considered in the pre-renovation stage (the weighting factor of woodfuels is 0.65) and a geothermal heat pump in the post-renovation stage. As the electricity consumption increases significantly, the total reduction of primary energy consumption is considerably lower than in the case of other building types.

Table 20. Changes in energy use.

	Before renovation, kWh/(m²y)	After renovation, kWh/(m²y)	Reduction, %

Efficient district heating	Heating	Electricity	WSEU	Heating	Electricity	WSEU	Heating	Electricity	WSEU
Private house*	190	25	174	0	65	130	100%	-160%	25%
Apartment building	170	35	181	70	38	122	59%	-9%	33%
Office	130	70	225	70	45	136	46%	36%	40%
Commerce	80	140	332	55	85	206	31%	39%	38%
Education	140	30	151	55	40	116	61%	-33%	23%

Natural gas	**Before renovation, kWh/(m²y)**			**After renovation, kWh/(m²y)**			**Reduction, %**		
	Heating	Electricity	WSEU	Heating	Electricity	WSEU	Heating	Electricity	WSEU
Private house*	190	25	174	0	65	130	100%	-160%	25%
Apartment building	170	35	240	70	38	146	59%	-9%	39%
Office	130	70	270	70	45	160	46%	36%	41%
Commerce	80	140	360	55	85	225	31%	39%	38%
Education	140	30	200	55	40	135	61%	-33%	33%

*transition from a stove to a heat pump is taken into account in the case of private houses

The final energy consumption reduction potential is around 60%.

A final energy consumption reduction of up to 6.9 TWh (59%) could be possible if the buildings covered with the strategy were fully renovated. Heating consumption can be lowered up to 6.4 TWh (70%) and electricity consumption up to 0.5 TWh (20%). The use of electricity changes considerably less compared to heating because buildings that previously lacked compliant climate control must be fitted with appropriate building services systems, which results in a slight increase in electricity consumption.

In addition to renovation, the final energy consumption of buildings addressed in the strategy reduces on the account of buildings falling into disuse. As at 2020, the total area of buildings in use is 76 M square metres. The total area of buildings that are not fully renovated is 70 M square metres. Considering the forecasted abandonment (around 20% of the area), 54 M square metres will need renovation by 2050.

Table 21. Change in final energy consumption.

Final consumption	**Final consumption 2020 TWh/y**			**Final consumption 2050 TWh/y**			**Reduction, %**		
	Heating	Electricity	TOTAL	Heating	Electricity	TOTAL	Heating	Electricity	TOTAL
Private house*	2.9	0.4	3.2	0.5	0.6	1.1	82%	-49%	67%
Apartment building	3.1	0.6	3.8	1.0	0.5	1.6	68%	15%	59%
Office	0.4	0.2	0.7	0.2	0.1	0.3	58%	49%	55%
Commerce	0.3	0.4	0.7	0.1	0.2	0.4	45%	51%	49%
Education	0.4	0.1	0.5	0.1	0.1	0.2	66%	-15%	52%
Other buildings	1.9	0.9	2.8	0.7	0.6	1.3	64%	34%	55%
	9.0	**2.7**	**11.7**	**2.7**	**2.1**	**4.8**	**70%**	**20%**	**59%**

*in the case of private houses it is considered that 50% of private houses will install a heat pump and 50% a boiler as a heat source

The CO_2 emission reduction potential is around 90%.

In 2020, the total CO_2 emissions of the buildings addressed in the strategy are 4.4 M t CO_2/y. Considering the renovation volumes proposed in the strategy and the estimated reduction of the specific emissions of CO_2 from the electricity and district heating until 2050, the

CO_2 emissions reduction potential of renovation of existing buildings is around 3.9 M t CO_2/y, which forms 89% of current CO_2 emissions.

The 2020 specific emission factors of energy carriers are based on the study "Energiakandjate kaalumistegurid" [Weighting Factors for Energy Carriers][32]. Electricity has a specific emission factor of 1.15 t CO_2/MWh and heating 0.15 t_2/MWh. The specific emission factors for the period 2020-2050 are based on the study "Eesti kliimaambitsiooni tõstmise võimaluste analüüs" *[Reaching Climate Neutrality in Estonia]*[33]. The average specific emission factors for the period 2020-2030 are 0.83 t CO_2/MWh for electricity and 0.12 t CO_2/MWh for heating. The average specific emission factors for the period 2030-2040 are 0.31 t CO_2/MWh for electricity and 0.09 t CO_2/MWh for heating. The average specific emission factors for the period 2040-2050 are 0.16 t CO_2/MWh for electricity and 0.05 t CO_2/MWh for heating.

Table 22. Changes in CO_2 emissions.

CO_2 emissions	**CO_2 emissions in 2020, t/y**			**CO_2 emissions in 2050, t/y**			**Reduction, %**		
	Heating	Electricity	TOTAL	Heating	Electricity	TOTAL	Heating	Electricity	TOTAL
Private house*	429,000	432,000	860,000	25,000	90,000	120,000	94%	79%	86%
Apartment building	467,000	737,000	1,200,000	50,000	88,000	140,000	89%	88%	88%
Office	66,000	270,000	340,000	9,000	19,000	30,000	86%	93%	91%
Commerce	38,000	515,000	550,000	7,000	35,000	40,000	82%	93%	93%
Education	62,000	102,000	160,000	7,000	16,000	20,000	89%	84%	88%
Other buildings	288,000	1,030,000	1,320,000	34,000	94,000	130,000	88%	91%	90%
	1,350,000	**3,086,000**	**4,430,000**	**132,000**	**342,000**	**480,000**	**90%**	**89%**	**89%**

*in the case of private houses it is considered that 50% of private houses will install a heat pump and 50% a boiler as a heat source

The analysis of final energy consumption and CO_2 emission reduction of the buildings does not include buildings erected after 2000 and new buildings erected between 2020-2050.

6.8 Conclusions on renovation activity to date

Current renovation activities have not been sufficient for renovating the existing buildings by 2050. If current trends continue, 80% of private houses, 68% of apartment buildings and 60% of non-residential buildings will remain unrenovated by 2050. Of the buildings addressed in the strategy, only the buildings owned by the central government will be renovated in the volume required per year, the total area of which forms a very small share (~1.5%) of all of the buildings that need renovation.

Renovation of **private houses** mainly depends on the owner's wish to commence renovation work and their capacity to make investments. Many

[32] Tallinn University of Technology. Energiakandjate kaalumistegurid *[Weighting Factors for Energy Carriers]*. 2017

[33] SEI Tallinn. Eesti kliimaambitsiooni tõstmise võimaluste analüüs *[Reaching Climate Neutrality in Estonia]*. 2019. https://www.sei.org/publications/eesti-kliimaambitsiooni-tostmise-voimaluste-analuus/

private house owners do not have the financial capacity to undertake a full renovation all at once. The cost of a full renovation of a medium-sized private house (~160 m^2) is around €60,000. Incomes do not allow many owners of private houses to make larger investments at once and renovation is conducted step by step.

Apartment buildings have been renovated in full in Estonia for already 10 years. The financing system, the technical solutions and apartment associations' desire to renovate are there. The main bottlenecks to date have been the unstable financing of support measures and uneven regional distribution of aid. Apartment buildings located outside centres require more support in terms of both financing and advice. 50% support is not always sufficient in regions with low-value real estate as banks may not grant apartment associations loans in the amount required for a full renovation. Energy costs are low compared to the cost of renovation, which affects the cost-efficiency of renovation. Even with a 40% support the total expenses of apartment owners (energy, renovation loan and maintenance) increase around 20% after renovation.

The owner's initiative is paramount when renovating **residential buildings**. A survey by Statistics Estonia[34] on the energy consumption of households highlighted that 38.1% of the surveyed households have not improved the heat retention of their homes. Around a half (46.4%) reported lack of money as the reason. 17.1% considered the existing heating sufficient and 14.6% lived in recently built buildings, which did not require insulation. 58% of households that had not improved heat retention were not planning to insulate their homes in the future.

Central-government buildings are subject to the obligation to renovate 3% of the floor area per year according to the energy efficiency directive. Estonia has fulfilled this obligation. As a bottleneck, the summary report on state real estate management highlighted that making central-government buildings comply with the minimum energy performance requirements for buildings has not previously been a planned or managed activity, as there is no long-term investment plan.

Local governments renovate using both support and their own funds, but the volume of renovation with own funds and the specific link between renovation with both own funds and support and energy savings cannot be assessed on the basis of data available. The State Audit Office report[35] that analysed the condition of buildings owned by local governments highlighted insufficient volume of aid allocated for renovation and the fragmentation of support as the main deficiencies of support measures designed for local government buildings. A third of buildings that received support are still in poor condition, as small aid amounts allowed buildings to be renovated only partially.

[34] Statistics Estonia. Leibkondade energiatarbimise uuring *[Household Energy Consumption Survey]*. 2012
[35] State Audit Office. Problems related to the use of European Union and other infrastructure support in local governments. 2017

Interviews conducted with owners of **private sector** non-residential buildings show that the current functioning logic of the commercial property market is not conducive to carrying out full renovations. The tenant covers the building management expenses and energy costs form a small share of the total expenses. Conscious tenants are more interested in good interior climate than the building's energy performance. Renovation work is mainly initiated due to a change in the building's use, change of ownership, change of tenant and other activities rather than high energy costs. Energy costs are generally covered by the tenant. Thus, the owner of the real estate does not have a direct motivation to improve energy performance. People are not yet interested in or are unable to look at the indirect benefit and the bigger picture.

At the same time, commercial property owners are aware that buildings are aging and property owners are forced to upgrade their buildings in order to stay on the market. The volume of renovation is the main question upon planning work. Larger projects with a payback period of over 20 years are not attractive to owners. Owners of commercial real estate expect the payback period of the investment to be less than 10 years.

Owners of private sector non-residential properties highlighted constant changes to energy performance regulations as another major problem. Requirements that are amended every five years and changes in calculation methodology (e.g. changes in weighting factors) make preparing a long-term view more difficult. Future energy performance requirements for buildings are unknown. Property owners would like to know the changes to be introduced in building energy performance regulations and implementation time of new requirements at least 10 years in advance. Additionally, changes resulting from energy calculation methodology (e.g. changes in weighting factors) do not affect the building's actual energy use and energy use-related costs to the property owner.

7 Volumes until 2050

7.1 Renovation need

Considering the number of residential buildings currently in use, the volume of renovations completed to date and the estimated residential building abandonment rate, 105,000 private houses with a total area of 14 M m^2 and 14,000 apartment buildings with a total area of 18 M m^2 should be renovated in full by 2050. A full renovation means a renovation that results in at least energy class C.

Table 23. Residential building renovation volume up to 2050.

	Existing		Renovated		Falling into disuse		In need of renovation	
	Quantity	Area, m^2	Quantity	Area, m^2	Quantity	Area, m^2	Quantity	Area, m^2
Private houses	155,000	19,998,000	10,000	1,500,000	40,000	4,800,000	105,000	14,000,000
Apartment buildings	22,600	28,378,000	3,000	5,000,000	5,300	5,000,000	14,000	18,000,000

0.9 M square metres of central-government buildings and 4 M square metres of local government buildings in the non-residential sector and 17 M square metres of buildings in the private sector need renovation. The total area of residential buildings that need renovation is 22 M square metres.

According to the central-government building energy performance inventory[36], as at 2017, 812,000 m^2 needed to be brought in line with the minimum energy performance requirements. In the strategy, the area of central-government buildings is somewhat larger than what is reported in the energy performance inventory because the strategy includes buildings that are not covered by the inventory (e.g. the buildings of the State Forest Management Centre that are entered in the State Real Estate Registry). The difference between the total area of buildings in need of renovation and the areas provided in the central government building energy performance inventory and the strategy is 6%, which does not significantly affect the required annual renovation volume of central-government buildings.

Table 24. Renovation need of non-residential buildings until 2050.

	Central government	Local government	Private sector	Total
	Area, m^2	Area, m^2	Area, m^2	Area, m^2
OFFICE	271,000	279,000	2,760,000	3,310,000
ACCOMMODATION	74,000	207,000	520,000	801,000
COMMERCE AND SERVICES	69,000	712,000	2,440,000	3,221,000

[36] Ministry of Finance. Energiatõhususe inventuuri aruanne *[Energy Performance Inventory Report]*. 2017 https://www.rahandusministeerium.ee/et/eesmargidtegevused/riigi-kinnisvararegister/portfelli-ulevaade/energiatohususe-inventuur

EDUCATION, RESEARCH	243,000	2,212,000	690,000	3,145,000
HEALTHCARE	12,000	205,000	590,000	807,000
WAREHOUSES	19,000		3,060,000	3,079,000
INDUSTRY	7,000		6,880,000	6,887,000
SPECIAL-PURPOSE BUILDINGS	164,000		150,000	314,000
OTHER		427,000	0	427,000
	860,000	**4,000,000**	**17,100,000**	**22,000,000**

Taking into account all private houses (14 M square metres), apartment buildings (18 M square metres) and non-residential buildings (22 M square metres), a total of 54 M square metres of buildings are in need of renovation by 2050. A full renovation can immediately be undertaken in building sectors that already have functioning full renovation processes: central-government buildings, local government buildings and apartment buildings. Building sectors, where the full renovation market is still waiting to be built, such as private sector non-residential buildings and private houses, will likely taken up at a later time. The creation of processes required for full renovation of these buildings should also commence immediately, but since the implementation of solutions and processes takes time, the majority of the renovation activity is estimated to take place between 2035-2045.

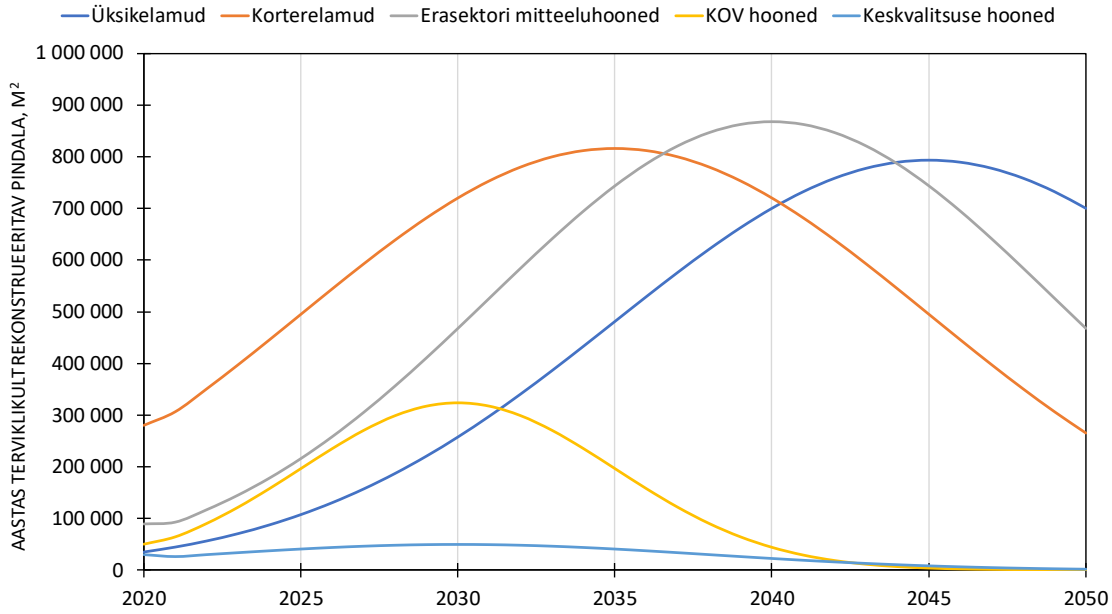


Figure 34. Renovation need by building sectors.

Üksikelamud	Private houses
Korterelamud	Apartment buildings
Erasektori mitteeluhooned	Private sector non-residential buildings
KOV hooned	Local government buildings
Keskvalitsuse hooned	Central-government buildings
Aastas terviklikult rekonstrueeritav pindala, m^2	Fully renovated area per year, m^2

When looking at the total annual volumes of different building sectors, the area of buildings that should be fully renovated between 2035-2040 is ~2.3 M square metres, which constitutes around a fivefold increase compared to the current volumes.

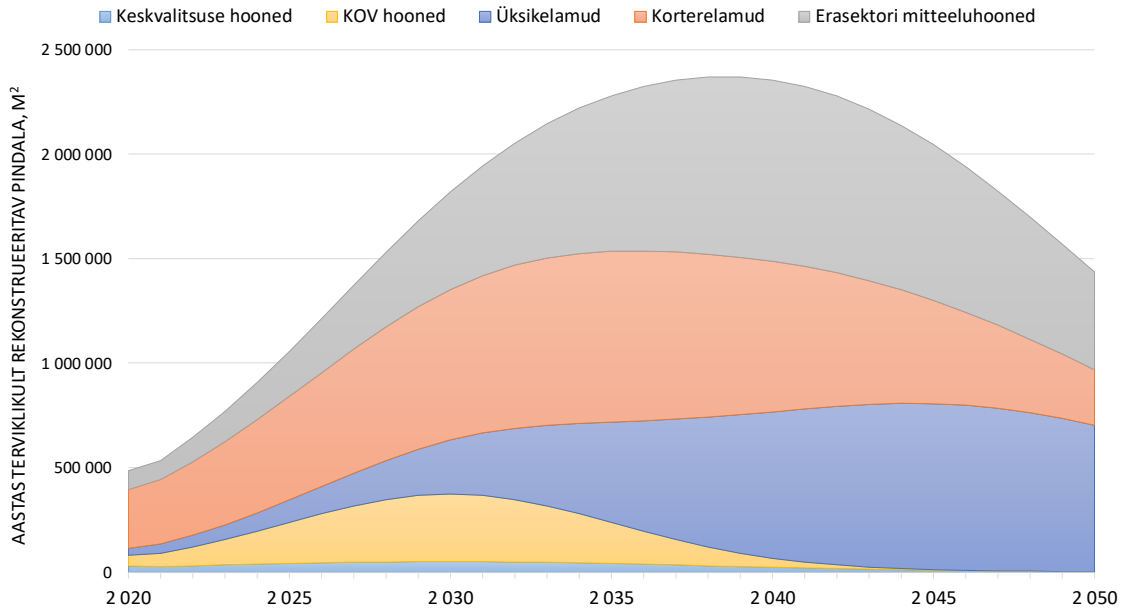


Figure 35. Cumulative annual renovation needs.

Keskvalitsuse hooned	Central-government buildings
KOV hooned	Local government buildings
Üksikelamud	Private houses
Korterelamud	Apartment buildings
Erasektori mitteeluhooned	Private sector non-residential buildings
Aastas terviklikult rekonstrueeritav pindala, m^2	Fully renovated area per year, m^2

Upon distributing renovation volumes, the average annual volumes of renovations completed to date are regarded as the situation as at 2020. Upon preparing calculations, the full programme is considered, i.e. all of the existing buildings are renovated by 2050. 22% of the area of unrenovated buildings would be renovated by 2030, 64% by 2040 and 100% by 2050. In practice, it can be assumed that around 20% of privately owned buildings (private houses, apartment buildings, private sector non-residential buildings) will remain unrenovated, because the owners do not wish to renovate their buildings.

Table 25. Renovation volumes proposed by the strategy until 2050, by floor area.

	Area to be renovated, m²						
	2021-2025	**2026-2030**	**2031-2035**	**2036-2040**	**2041-2045**	**2046-2050**	**TOTAL**
Private houses	400,000	950,000	1,900,000	3,100,000	3,900,000	3,800,000	14,000,000
Apartment buildings	2,280,000	3,200,000	4,000,000	3,900,000	3,000,000	1,800,000	18,000,000
Private-sector non-residential buildings	840,000	1,800,000	3,200,000	4,200,000	4,100,000	2,900,000	17,000,000
Local government buildings	680,000	1,400,000	1,300,000	480,000	70,000	0	4,000,000
Central-government buildings	200,000	240,000	230,000	150,000	70,000	20,000	900,000
	4,400,000	**7,600,000**	**10,600,000**	**11,800,000**	**11,100,000**	**8,500,000**	**53,900,000**

7.2 Financing needs

The full renovation of all buildings costs around €22 B.

The renovation costs of the buildings is calculated using the 2019 costs of full renovation and the annually renovated areas provided in the previous chapter. The renovation cost of public sector buildings takes

into account the cost of renovation work related to energy savings of €600/m^2. Renovation of public sector buildings is often initiated on grounds other than energy saving and the average cost of full renovation of the buildings is around €1,100/m^2. As the aim of the strategy is to attain the climate goals, only the cost of the work to achieve energy savings is taken into account when calculating the costs. In the case of the cost of renovating private sector non-residential buildings, it is considered that the cost is €600/m^2 even in the case of buildings whose building envelopes also need upgrading (approximately 2/3 of the buildings). The cost of renovation of buildings where upgrading building services systems will suffice is around €200/m^2 (approximately 1/3 of the buildings). The average renovation cost of private sector non-residential buildings calculated in the strategy is 0.33 × 200 + 0.67 × 600 = €450/m^2.

The annual renovation funding need will increase 4 to 5 times from the current around 200 M euros per year to around 900 M euros per year. On the basis of the cost of 2019 renovations, the total cost of the full renovation of buildings in need of renovation would be around €22 B. The average cost of the full renovation of all buildings is around €400/m^2 (€24 B / €54 M square metres).

In the coming years, the measures of the long-term renovation strategy will be implemented using the state's tax revenue, the funds of the European Union budget framework for 2014-2020 (above all, the funds of the European Regional Development Fund, the Cohesion Fund and, to a smaller extent, Horizon 2020) and the auctioning revenue from the European Union scheme for greenhouse gas emission allowance trading (in accordance with the objectives listed in Article 10 (3) of directive 2003/87/EC117, subsection 161 (4) of the Atmospheric Air Protection Act and the state's budgetary strategy).

A more specific distribution of measures, the schedule and state budget funds allocated for execution thereof are, among other things, decided upon preparing the state mid-term budgetary strategy. Considering the high importance of the renovation wave in the documents of the European Green Deal and the European Union Recovery Plan, it would be reasonable to ensure respective Union financial instruments for Member States.

Table 26. Costs of the renovations proposed by the strategy until 2050.

		Renovation cost, €M						
	Cost, €/m_2	**2021-25**	**2026-30**	**2031-35**	**2036-40**	**2041-45**	**2046-50**	**TOTAL**
Private houses	400	161	381	776	1,236	1,541	1,504	5,600
Apartment buildings	300	683	953	1,189	1,160	886	530	5,400
Private-sector non-residential buildings	450	379	811	1,437	1,884	1,828	1,312	7,650
Local government buildings	600	409	869	792	287	41	2	2,400
Central-government buildings	600	119	142	136	90	41	13	540
		1,749	**3,156**	**4,330**	**4,657**	**4,337**	**3,361**	**21,590**

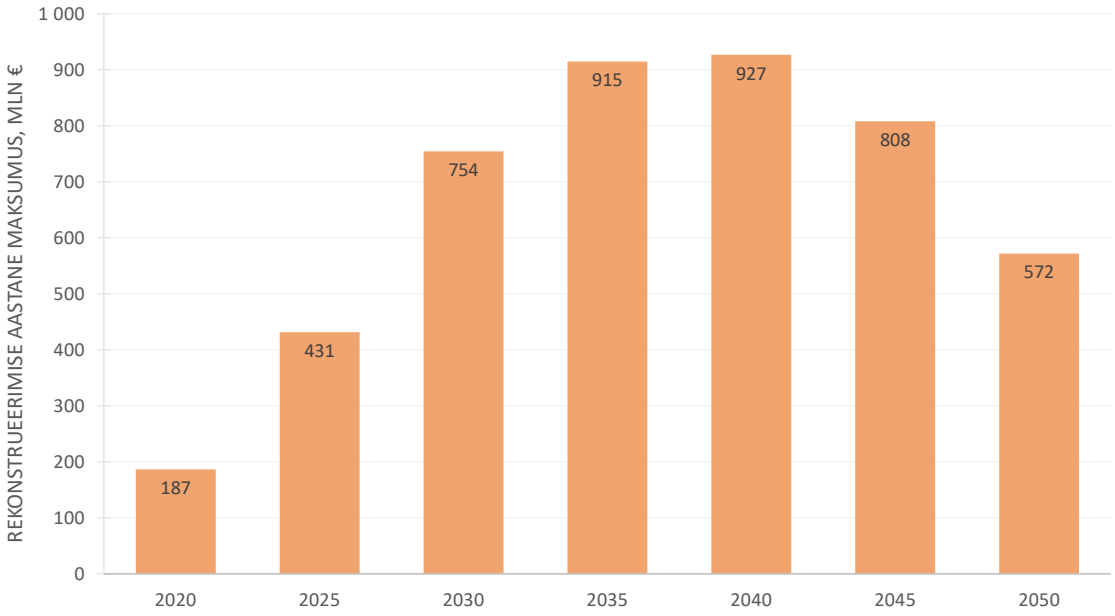


Figure 36. Annual financing needs for the full renovation of the buildings.

Rekonstrueerimise aastane maksumus, mln €	Annual cost of renovation, M €

The support rates of the current support measure are considered as possible support for full renovation. For renovating with the help of support, the annual need for support would be up to €400 M based on the 2019 costs. The more specific forecast covers the period until 2030. The financial needs for the support for subsequent periods are to be specified later, as the nature and implementation of measures change over time – at first, the proportion of support will likely be higher in order to get the renovation process going, while later implementation will focus on loans and other measures that are more suitable for the market logic and have a smaller effect on the state budget. The financial needs for the support will be specified during the merging of the Estonian National Energy and Climate Plan and the building renovation strategy and the subsequent regular updating thereof. The final decisions on financing the support required for implementing the strategy are made during the state budgetary strategy preparation process.

Table 27. Support needs until 2030.

		Renovation support, €M	
	Support, %	**2020-2025**	**2026-2030**
Private houses	30	48	114
Apartment buildings	40	273	381
Private-sector non-residential buildings	40	152	324
Local government buildings	50	204	435
Central-government buildings	100*	119	142
		796	**1,396**

* This is not the usual financial support as the central government is the owner of the buildings.

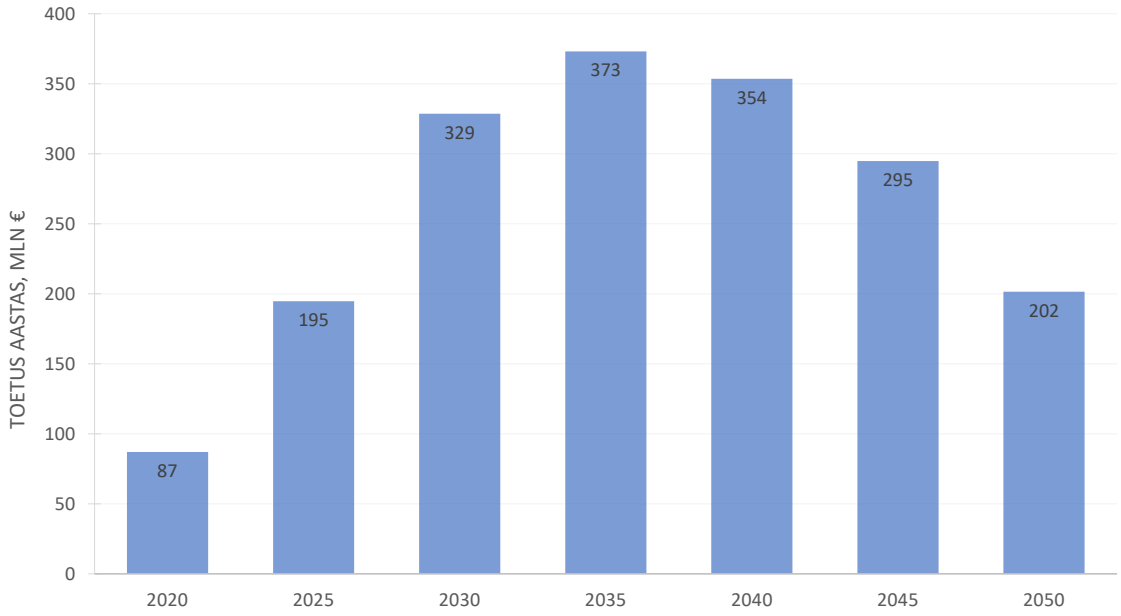


Figure 37. Annual financial support for the full renovation of the buildings.

Toetus aastas, mln €	Annual support, M €

8 New buildings

On average, 1,200 new private houses are taken into use per year.

8.1 Volume of new residential building construction

The construction of new residential buildings shows an upward trend. In the last five years, building permits have been issued for 1,600 and use permits for 1,200 private houses per year on average. The annual average net area of new private houses with use permits is 200,000 m^2, which forms 1% of the area of private houses taken into use before 2000.

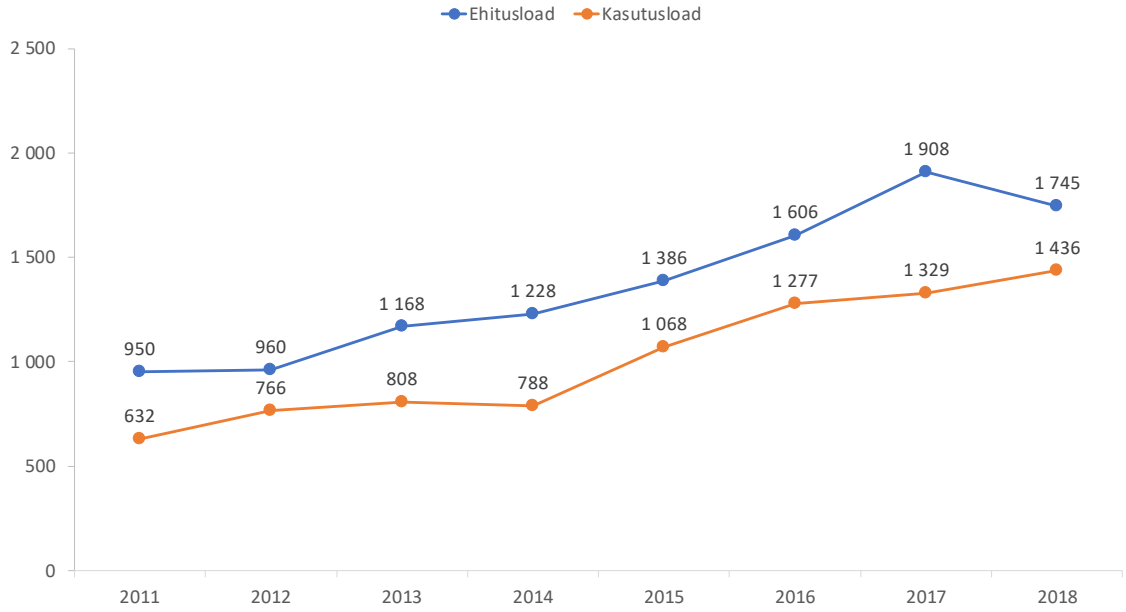


Figure 38. Building and use permits of new private houses.

Ehitusload	Building permits
Kasutusload	Use permits

New private houses are built all across Estonia.

53% of new private houses taken into use are located in Harju County, but new private houses that have been authorised for use can be found in every county.

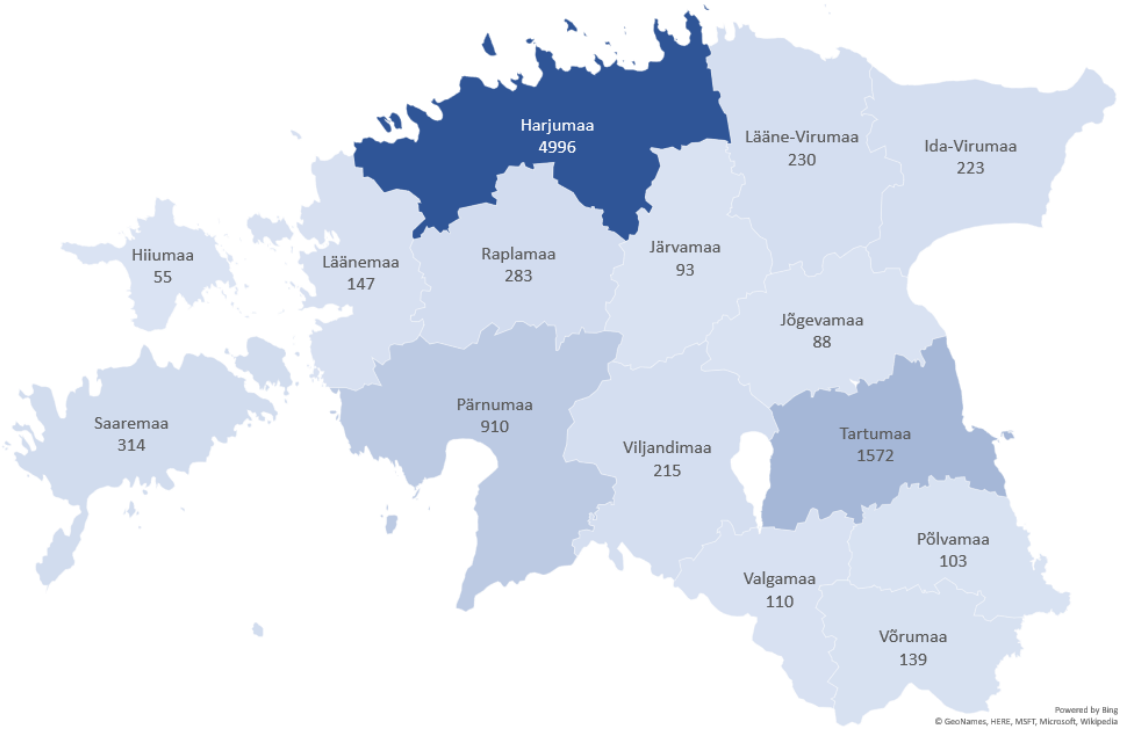


Figure 39. Distribution of private houses that have been granted use permits as of 2011 by counties (based on the 2019 administrative division).

Hiiumaa	Hiiu County
Saaremaa	Saare County
Läänemaa	Lääne County
Harjumaa	Harju County
Lääne-Virumaa	Lääne-Viru County
Ida-Virumaa	Ida-Viru County
Raplamaa	Rapla County
Järvamaa	Järva County
Jõgevamaa	Jõgeva County
Pärnumaa	Pärnu County
Viljandimaa	Viljandi County
Tartumaa	Tartu County
Valgamaa	Valga County
Põlvamaa	Põlva County
Võrumaa	Võru County

An average of 125 new apartment buildings are taken into use annually.

In the last five years, building permits have been issued for 180 and use permits for 125 apartment buildings per year on average. The annual average net area of new apartment buildings with use permits is 1.2 m^2, which forms 0.4% of the area of apartment buildings taken into use before 2000.

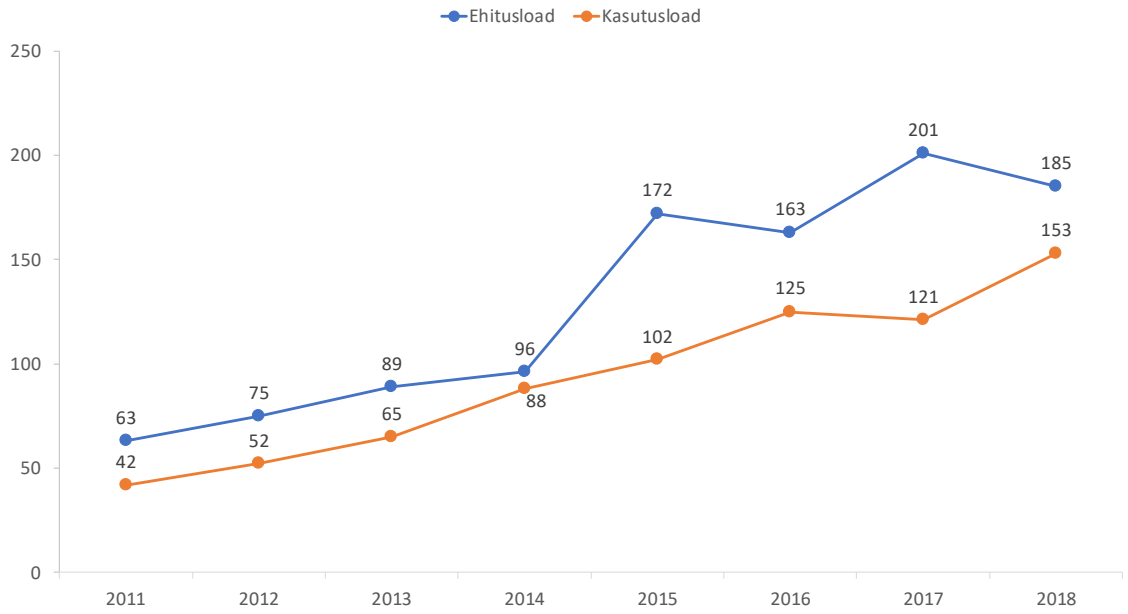


Figure 40. Building and use permits of new apartment buildings.

Ehitusload	Building permits
Kasutusload	Use permits

New apartment buildings are mainly built in Harju County and Tartu County.

New apartment buildings are mainly built in three regions: Harju, Tartu and Pärnu Counties. 70% of new apartment buildings taken into use are located in Harju County (52% in Tallinn) and 23% in Tartu County. Six counties have not taken into use any new apartment buildings in the last nine years.

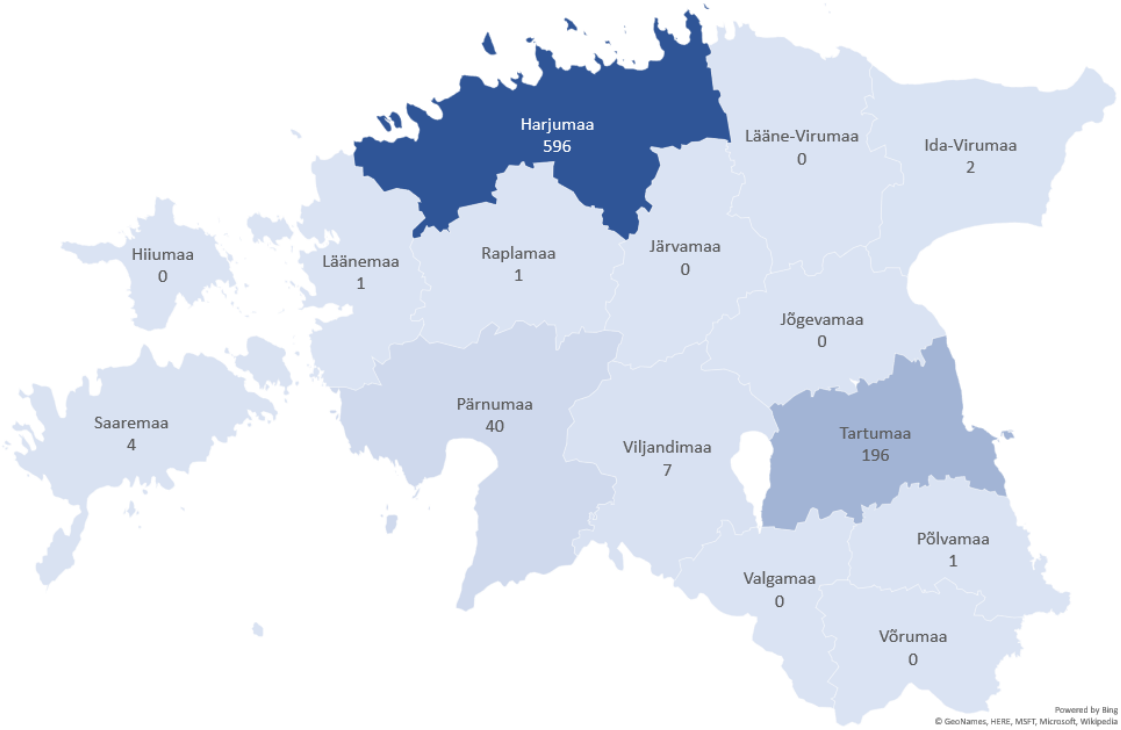


Figure 41. Distribution of apartment buildings that have been granted use permits as of 2011 by counties (based on the 2019 administrative division).

Hiiumaa	Hiiu County
Saaremaa	Saare County

Läänemaa	Lääne County
Harjumaa	Harju County
Lääne-Virumaa	Lääne-Viru County
Ida-Virumaa	Ida-Viru County
Raplamaa	Rapla County
Järvamaa	Järva County
Jõgevamaa	Jõgeva County
Pärnumaa	Pärnu County
Viljandimaa	Viljandi County
Tartumaa	Tartu County
Valgamaa	Valga County
Põlvamaa	Põlva County
Võrumaa	Võru County

9 Impact of renovation

9.1 Share of renovation in construction sector

According to Statistics Estonia, in 2018, Estonian construction companies performed construction work in Estonia and foreign countries in the total amount of €3 B, of which buildings accounted for €1.9 B and civil engineering works €1.1 B. The financial volumes of construction work have increased significantly over the recent years, but the number of workers employed by the sector has remained at around 60,000. Temporary workers from other countries used in the construction sector are not fully reflected in the official statistics. In addition to temporary workers, an increase in productivity can also be expected on the account of achievement of economies of scale from larger projects.

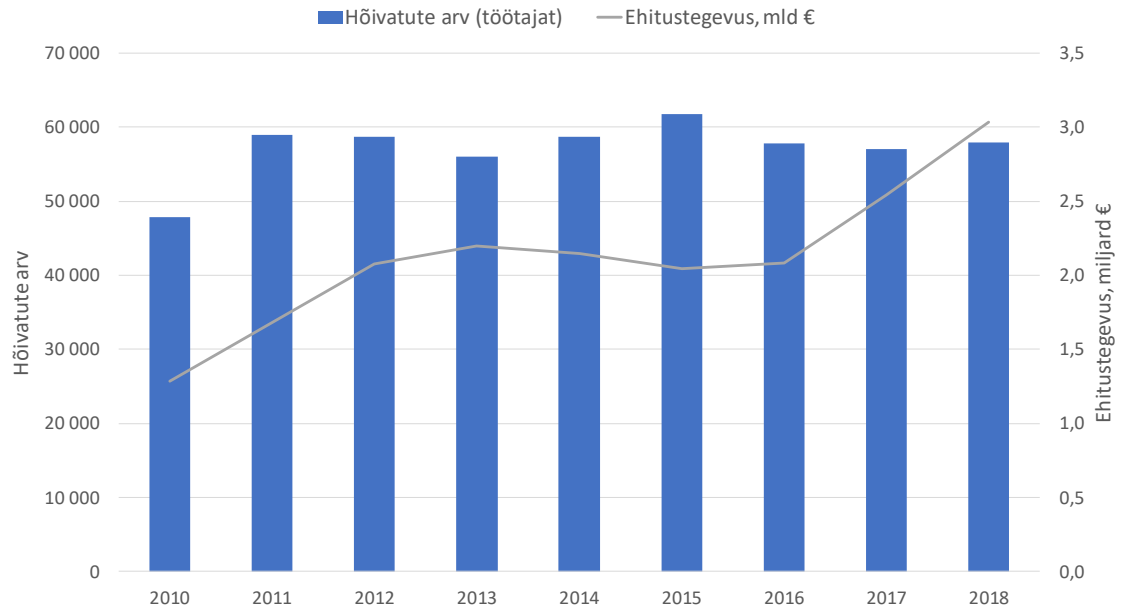


Figure 42. Construction activity and number of workers employed in the construction sector.

Hõivatute arv (töötajat)	Number of employed (workers)
Ehitustegevus, mld €	Construction activity, B €
Hõivatute arv	Number of employed
Ehitustegevus, miljard €	Construction activity, B €

Construction activity develops inertly in the general economic environment, i.e. people build more if the economy is generally doing well and less when it is not. Considering that construction hit the lowest point in 2010 and peaked in 2019, the 2015 building construction volume of €1.3 B could be regarded as the average. Full renovations account for approximately €200 M of this. Provided that 17 jobs are created for every €1 M investment[37], the number of workers employed in full renovation is around 3,400. Full renovation of all unrenovated buildings would require an investment of up to a billion euros per year, which in turn requires around 17,000 workers to be employed in full renovation.

Workers added to those engaged in full renovation do not constitute all of the extra workers needed in the construction sector. Workers who have been engaged in constructing new buildings would be redistributed in the sector to renovate buildings. The prioritisation of renovation must therefore also be taken into account in construction decisions. The purpose of the gradual increase of the renovation volumes presented in the strategy is to shape the market without overheating it, incl. by avoiding a disproportionate increase of construction prices. The need for workers can be covered by an increase in productivity arising from the adoption of new technologies.

9.2 Impact of building renovation

Renovation of buildings is a regional and social measure that has a long-term effect on shaping the living environment. In addition to a direct reduction of energy consumption, other important factors must be taken into account when renovating buildings.

Energy poverty is not currently a widespread problem in Estonia. According to the European Energy Poverty Observatory data[38], 2.9% of households reported problems with heating their homes and 6.3% of households had energy bill debts. When planning full renovation of existing buildings, it must be remembered that some households are not capable of carrying out renovation. Renovation of a building requires the owner to make a financial contribution even if there are support measures available and households with lower incomes are not able to provide that. Vulnerable households need additional support for participating in energy saving measures.

The ways of ensuring **accessibility** in buildings are currently very different**.** Users of buildings change and therefore it must be ensured during renovation that the building can be used by all population groups (parents with prams, children, elderly and disabled people). In order to ensure the accessibility of public spaces and buildings to all

[37] Pikas, E.; Kurnitski, J.; Liias, R.; Thalfeldt, M. (2015). Quantification of economic benefits of renovation of apartment buildings as a basis for cost optimal 2030 energy efficiency strategies.
[38] Bouzarovski, S. & Thomson, H. (2019) Transforming Energy Poverty Policies in the European Union: Second Annual Report of the European Union Energy Poverty Observatory.

people and increase accessibility awareness, the Government Office has set up the Accessibility Task Force[39].

In the case of **towns with a shrinking population,** there is a need to take into account the population and infrastructure development principles in zoning and for concentrating the town centres. According to a doctoral thesis defended in the Tallinn University of Technology in 2019[40], shrinking local governments should above all focus on the quality of life of their residents and attractiveness of urban space is important for achieving this goal. In urban areas where the population is getting older or smaller, it is therefore important to not only demolish underused buildings but also to ensure full functionality of the urban space, using demolition as an opportunity to improve the availability of public services and the functions needed for the functioning of urban areas, by gathering these into synergistic spatial ecosystems. Moreover, abandoned and underused buildings affect the lives of people living nearby, as they have a strong negative symbolic value. Therefore, in shrinking towns, buildings should above all be renovated in the town centre (defined with zoning) and sustainable residential areas planned in the zoning.

Renovation of buildings plays an important role in designing **good public spaces**. By approaching each building individually without considering the whole picture, renovated buildings located in the same area will end up looking like an architectural patchwork. Therefore, in order to ensure a regional architectural whole and develop a good public space, it is necessary to follow the basic principles for high-quality space[41], zoning plans of local governments and architectural guidelines for renovating buildings in different regions.

Broader use of **local renewable energy** along with renovation of buildings. The best technical solution for densely populated areas is the installation of solar panels for producing electricity. The electricity consumption of buildings previously without ventilation systems that are fitted with mechanical heat recovery ventilation systems will increase as a result of the renovation. The increase in electricity consumption due to ventilation systems can be set off by producing electricity locally using solar panels. The CO_2 emissions of private houses where stove heating is replaced with a heat pump will also increase as a result of the renovation, because previously emission-free woodfuel is replaced by specific emission-intensive electricity. The increase in electricity use can be set off by installing solar panels.

Renovation allows buildings to be brought in line with contemporary safety requirements in order to ensure **safety of buildings**. The post-design life cycle of a majority of buildings has either ended or coming

[39] Accessibility Task Force https://www.riigikantselei.ee/et/ligipaasetavuse-rakkeruhm
[40] Jiří Tintěra, 2019. Urban Regeneration Strategies for Shrinking Post-Soviet European Communities: A Case Study of Valga, Estonia.
[41] Kvaliteetse ruumi aluspõhimõtted *[Basic principles for high-quality space]*: https://www.kul.ee/sites/kulminn/files/lisa_3_-_kvaliteetne_ruum_aluspohimotted.pdf

to an end, which has created an immediate need to repair their load-bearing structures (such as balconies and shelters). According to a survey conducted by the Technical Regulatory Authority in 2012 and 2013[42], 53% of the balconies of the 26 surveyed buildings showed severe structural deficiencies. Only 16% of balconies met all of the requirements. In addition to structures, the electrical systems and water and sanitation piping of buildings require safety upgrades.

When renovating buildings, attention must also be paid to the fire safety of the building (fire doors, building services system penetrations, gas equipment safety, shutdown of installed ventilation systems in the event of a fire, etc.). Work required to ensure the safety of the building must be considered eligible in support measures. For instance, installation of fire doors, replacement of indoor air-dependent gas water heaters with a centralised hot water supply system and automation required for ensuring fire safety.

In the case of national renovation support measures, areas located outside of the Tallinn region should be prioritised in order to ensure **regional balance**. If support measures are distributed on similar market conditions, they are concentrated in more capable areas, which exacerbates the uneven development of regions. The Estonian regional economy scenarios prepared by the Foresight Centre[43] point out that for the regional economy to function, changes are also required in regional living environments – renovation and upgrading of buildings and availability of high-quality office spaces. In addition to giving an advantage to regions outside the capital in support measures, extra measures, such as state guarantees for home loans and renovation loans outside larger cities and greater inclusion of the local government level in measures supporting renovation of buildings, should be taken. In urban areas where the population is getting older or smaller, it is important to ensure full functionality of the urban space, using renovation and demolition as an opportunity to improve the availability of public services and the functions needed for the functioning of urban areas, by gathering these into synergistic spatial ecosystems where possible.

Renovation of buildings also has a considerable impact on the **energy sector**. The use and import of fossil fuels and sales volumes of district heating companies will diminish. The need to invest in new energy production capacities will reduce. Buildings requiring less energy also allow for harnessing the potential of renewable energy solutions and distributed energy and an increase in energy independence and the security of the energy supply.

[42] Technical Regulatory Authority. 1960-1990 ehitatud korterelamute rõdude ja lodžade raudbetoonist eenduvate esipiirdepaneelide uuring *[A Study of Reinforced Concrete Front Panels of Balconies and Loggias of Apartment Buildings Built between 1960-1990]*. 2013

[43] Foresight Centre (2019). Eesti regionaalse majanduse stsenaariumid 2035 *[Estonian Regional Economy Scenarios 2035]*. https://www.riigikogu.ee/wpcms/wp-content/uploads/2019/02/Eesti-regionaalse-majanduse-stsenaariumid-2035.pdf

10 Measures

10.1 Adoption of new technological solutions

In order to increase renovation volume, technological solutions need to be developed. This must be done in terms of both construction work and preparatory work. Provided that the volume of new buildings will remain on the same level, technologies that are currently used make it very difficult to achieve around a fivefold increase in renovation volume. There is not enough labour to cover a rapid increase in volumes. Renovation capacity increases in periods when the volume of new construction temporarily decreases, but the labour challenge will re-emerge once the volume of new construction is restored. Labour shortage also occurs in the preparatory stage of renovation (energy auditors, designers, owner's consultants, etc.).

In addition to solving the labour problem, new technological solutions also allow to speed up processes and reduce the increase in the cost of construction arising from increased demand (see also 7.2 "Financing needs"). For instance, use of prefabrication allows for the achievement of economies of scale when renovating standard buildings and speeds up the renovation process. A quicker process allows more buildings to be renovated with the same amount of labour, and another important positive social impact is that in the case of residential buildings, buildings are not covered with scaffolding and netting for a long period of time.

Use of **prefabricated** external wall and roof elements to insulate the building envelope. Prefabrication could first be used for renovating standard buildings (e.g. apartment buildings). In larger cities, such as Tallinn and Tartu, there are many apartment buildings that were constructed in the Soviet era by residential construction combines on the basis of standard designs. For instance, the Tallinn Residential Construction Combine standard reinforced concrete panel apartment building designs 1-464 (Mustamäe) and 111-121 (Õismäe and Lasnamäe) or Tartu Residential Construction Combine standard design 111-133 (Annelinn and county centres). Standard design 1-317 (so-called Khrushchyovka) built from bricks or concrete panels is also common. Apartment buildings prefabricated on the basis of standard projects could also be renovated using solutions prefabricated on the basis of standard solutions. Use of prefabrication would allow the renovation process to be automated and accelerated and ensure better quality.

Digital tools for preparing energy labels and energy audits. Development of virtual tools could be the next step in the digitalisation of the field. Use of virtual tools would help to reduce the time spent on preparing energy labels and energy audits and therefore also the costs. For instance, the tools in the Building Registry which automatically prepare documents or make calculations simpler (calculating the heating costs for a normal year, energy costs per square metre, etc.) would allow not only energy labels but also energy audits to be standardised. The added value would be the possibility to analyse the data of the labels prepared and audits performed. Current energy

labels and energy audits are generally presented as documents in PDF format, which are not machine-readable and cannot therefore be easily used for analysis. In the environment, which is part of the Building Registry, audits could be linked to the data of the Building Registry and the energy use data entered in the audit would be automatically usable by the system for analysing the bigger picture of the energy use of buildings.

Simplified digital tools for building owners. The most important condition for renovating a building is the owner's will to renovate. Simpler virtual tools would enable building owners to think through the initial versions themselves without incurring any costs.

For example, a tool for private house owners that is based on technical solutions, where the user can enter the parameters of an existing building (wall type, window type, heating system, ventilation system) and choose between different options for improving energy performance (thickness of the external wall and roof insulation, new triple-glazed windows, replacement of the heating system and installation of a ventilation system and solar panels).

An energy performance assessment tool that is based on energy costs could be developed for owners of commercial properties. Owners of commercial properties are not generally aware of the building's energy consumption in units like kWh or kWh/(m^2y). The energy costs in euros are known. A building's energy consumption could be assessed on the basis of energy bills provided by the accountant and the cost of the energy unit. It would also be possible to offer general suggestions for reducing energy costs on the basis of the building's general technical specification and the main energy cost component (electricity or heating) determined on the basis of energy bills.

10.2 Research and development

Research and Development allows the quality to be improved and the processing of data collected about buildings to be automated, the problem of labour shortages to be alleviated, productivity to be increased and the total cost of renovation to be reduced.

Development of state registries improves the monitoring of renovation activities. The main bottleneck of preparing the renovation strategy was the lack of data. For instance, the Building Registry should allow data to be processed in order to answer the following questions:

- What is the share of full renovations in renovations completed?
- Which of the buildings to be renovated are owned by local governments and the central government?
- Which of the buildings in the Building Registry are protected under heritage conservation or of cultural or environmental value?

Mapping of decision-making processes provides the opportunity to understand why and when property owners decide to start renovation work. Support measures have provided a certain insight of the owner's perspective in terms of apartment buildings and public sector buildings. The processes of renovating private houses and commercial properties have not yet been thoroughly mapped. It is impossible to successfully guide renovation processes without knowing why and on what conditions property owners decide to start renovation work.

Development of **strategic spatial planning** allows to apply the basic principles for high-quality space[44] when renovating buildings. There is a need to develop general architectural guidance materials for renovating different types of buildings and local government guidance materials for renovating buildings in certain regions.

Analysis of the broader impact of **renovation of buildings** . The economic impact of building renovation measures, the impact of global warming on potential energy savings of buildings, the impact of building renovation on the achievement of climate neutrality, the options for broad-based implementation of innovative solutions, the results of pilot projects conducted in other countries and the potential to transfer international practices should be analysed in detail. The impact of global warming requires an analysis in terms of renovation solutions and the longevity of materials used. Solutions can be found to reduce changing climate burdens and risks and avoid a new renovation wave arising from insufficient weatherproofing in the future. New technical expertise that is obtained as a result of development activity must be implemented both internally in the construction sector and on a cross-sectoral basis (property management, insurance, urban planning, etc.), which requires, among other things, training of specialists and guidance materials.

Development of **technical expertise** allows to renovate with sustainable, healthy and real energy savings, which do not come at the expense of the interior climate. Having guidance materials and expertise allows designers and construction workers to know what is expected from them and contractors to develop economical and affordable standard solutions. To date, more than 10 doctoral theses have been defended on the topic of renovation of buildings and the results are well-implemented.

Good results have already been achieved in the case of apartment buildings and public sector buildings. The situation of private houses is the most complicated because the structures of older buildings may pose difficulties due to moisture and mould, but there is essentially no technical literature on renovation of small residential buildings. Renovation of commercial properties has also mostly involved individual energy saving works, which is why there is a lack of general experience of full renovation. The practice of improving the energy

[44] Kvaliteetse ruumi aluspõhimõtted *[Basic principles for high-quality space]*: https://www.kul.ee/sites/kulminn/files/lisa_3_-_kvaliteetne_ruum_aluspohimotted.pdf

performance of buildings that have cultural or environmental value or are acknowledged as architectural monuments also requires the development of expertise because the requirements for renovating valuable buildings are more detailed and achieving energy class C is not often possible or even reasonable.

Increasing renovation volume creates a new challenge on the market in the form of labour shortage. This creates a need for development work that would allow more renovation using the existing workforce, i.e. to improve productivity. Currently, the only known way to significantly improve productivity is to transfer as much of the on-site work as possible to factories and start renovating using pre-fabricated components which are assembled on site.

The following research, development and innovation activities are required to increase technical expertise:

- Development of technical solutions and guidance materials for renovating small residential buildings. Taking into account the market situation, both renovation by individual work and full renovation must be enabled because both are conducted depending on the situation and needs of families.
- Cost-effective solutions for significant renovation of commercial properties. Currently, office or commercial buildings are not generally renovated to correspond to energy class C. There is a need to monitor the energy use of existing buildings and develop and test solutions that ensure real energy savings with a reasonable investment.
- Renovation using prefabricated components. In order to alleviate the labour shortage resulting from an increase in renovation volumes, there is a need to increase productivity and, in the long term, cost-efficiency. Industrial production in its simplest form is made possible by lightweight external wall and roof elements, which include the necessary building services system piping. Such solutions currently exist on larger markets where labour is more expensive.
- Reduction of CO_2 emissions achieved by the measures of the strategy and comparative analysis of measures in terms of emission reduction efficiency, i.e. marginal cost. The current analyses have been based on final energy consumption and the energy performance indicator (primary energy), but in the future, there is a need to determine the exact impact on emissions in the context of climate neutrality.

10.3 Awareness raising

In order to boost renovation of **private houses**, guidance materials on renovation aimed at owners of private houses must be developed. There are currently no comprehensive Estonian handbooks on renovating private houses. Guidance materials should be freely

available on the internet. The same internet address should also include information on possible support measures and web-based energy performance calculators aimed at owners of private houses.

Renovation of **apartment buildings** requires working with apartment associations that have not participated in existing renovation measures. According to apartment building support statistics, support is mainly applied for buildings with 30-40 apartments that are mostly located in centres. Smaller apartment buildings and those located outside of centres must also be included in the planning of further renovation measures. Apartment buildings that do not have a functioning apartment association also require attention in terms of raising awareness. Apartment associations were created automatically for apartment buildings that did not have an apartment association as at 1 January 2018. The estimated number of automatically created apartment associations is around 10,000.

Supporting the performance of energy audits would help to raise awareness among owners of **private sector commercial properties**. The purpose of this is to increase the awareness of commercial property owners of the energy consumption of buildings under their management and the possible energy savings and related benefits. A detailed energy audit would provide the property owner an overview of the possibilities of reducing energy costs, the work schedule, the costs and later changes in energy costs. Support could be applied for energy audits that have been used to carry out energy saving work. As an added value of the measure, a dataset on the energy use of non-residential buildings, the measures applied and the cost of measures would be created. Publishing of the dataset (in a format that does not allow specific buildings to be identified) would give owners and tenants the opportunity to compare the energy performance of their building with that of other buildings.

The audit must include the cost and feasibility of the measures, i.e. feasibility by stages. Additionally, the audit must specify the measures for later surveillance, monitoring and certification. If there is a wish to use the audit as a source document for investment support, economic calculations that take into account the partially related costs associated with renovation work must also be made together with the audit.

10.4 Demolition of buildings falling out of use

According to forecasts, up to around 5,000 apartment buildings and up to 10,000 non-residential buildings will fall into disuse by 2050. Demolition of disused buildings is mainly impeded by the resolution of ownership issues. In the case of apartment buildings, it is also hindered by the last residents of half-empty buildings moving to renovated buildings. In urban areas where the population is getting older or smaller, it is important to not only demolish underused buildings but also to ensure full functionality of the urban space. As a result, demolition can be used as an opportunity to centralise public services

and functions required for the functioning of urban areas and improve their availability.

10.5 Financing measures

Financing measures include loans, guarantees and support.

In order to facilitate renovation of **private houses,** it is important to address the market failure resulting from low property value. To finance renovation with a loan in regions where property values are lower, it must be possible to use state guarantees that are valid until the state loan agreement maturity date, which would allow banks to issue loans independent of the value of the collateral and against a state guarantee.

In order to increase the private house renovation activity, the support measure for private houses must be continued in order to address the market failure due to low financing capacity and target technical solutions used in renovation. The support rates of the support measure should be differentiated in accordance with the comprehensiveness of the planned renovation. A greater support rate for full renovation and a smaller support rate for individual works.

The focus of **apartment building renovation** must differ by region. Full renovation must above all be targeted at the centres of functional regions and second-tier centres. The measures for apartment buildings that are located in the immediate hinterland of cities and the periphery would depend on the capacity of apartment associations. Loans and support are either used for more comprehensive renovation of building envelopes and building services systems or renovation by individual works. In the case of apartment buildings that are in a more complicated situation (very low property value, partially emptied, the apartment association's capability to conduct renovation processes is very low), it should be able to renovate by individual work with the purpose of ensuring safe use (e.g. replacement of the old electrical or heating system) or preservation (e.g. replacement of a leaking roof) of buildings. Apartment associations that are located outside of centres may require a state-funded loan measure for carrying out renovation work. Loans would be available to apartment associations to whom commercial banks are not ready to grant renovation loans in the required amount.

One possibility to facilitate renovation of **private sector commercial properties** is renovation support that is based on the CO_2 emissions arising from the building's energy use. The support is based on the energy savings achieved as a result of renovation and the related CO_2 emission reduction. Upon supporting investments it is also considered that the CO_2 equivalent of coolants used in the equipment to be installed (refrigerators, heat pumps) is as small as possible. The support amount can be up to 50% of the total investment. The principle of the measure is that the reduction of CO_2 emissions resulting from the investment should be as big as possible. The more efficient the

measures, the larger the support. Support for achieving a 30% reduction of CO_2 emissions is smaller than the support for achieving a 50% reduction of CO_2 emissions.

Support, loans or guarantees are applied on the basis of the energy audit of the building, which includes the following information:

- the list of measures required to reduce the energy cost together with a detailed description of application thereof;
- a financial plan that takes into account all potential related costs;
- changes in the building's energy costs by measures and later total energy cost;
- CO_2 emissions reduced;
- a plan for monitoring changes in energy use and the method of proof.

The payback period of the whole investment for property owners must be less than 30 years (life cycle of building services systems), but a large part of the market considers renovation only if the payback period is less than 10 years. In addition to the payback period, the size of the building must be taken into account. In the case of the current measure, the proportion of the support (e.g. 30%, 40% or 50%) would not only depend on the amount of reduced CO_2 emissions, but also the size of the building. The smaller the building, the more expensive its renovation per square metre. Energy saving work should be carried out in full and a part of the support (e.g. 15%) paid out after a one-year monitoring period, when it is proved that the established energy saving goal was achieved.

The example of the calculation of a CO_2 emission reduction-based support measure is provided in Annex 11.1.

The support measures for renovation of **public sector** buildings are not built on a certain proportion of support, but on supporting energy saving work performed during renovation. The analysis of budgets of fully renovated public sector buildings showed that around 50% of the renovation cost is related to energy saving work. The rest of the work is related to changing the functionality, spatial planning and interior finishing of the building, etc.

Processes for renovating public sector buildings have been established. Provided that there is funding, the renovation volume of public sector buildings can be quickly increased by completing a prior analysis of its broader effects, incl. market capability, impact on the materials industry, jobs, etc. In the case of a rapid increase in the renovation volume of local government buildings, the process may be hindered by the local government's creditworthiness. Less capable local governments are allowed to take a loan of up to 60% of the costs of the main activity. More capable local governments are allowed to take a loan of up to 100% of the costs of the main activity. According to the

Ministry of Finance, in 2018, the average net debt burden of local governments was 28%[45]. Thus, upon the existence of support measures, many local governments would have the financial capacity to increase the volume of full renovation of local government buildings.

10.6 Creating additional services for residential building investments

One possible measure is making investments via the KredEx Foundation, so as to involve private partners as financers while minimising the burden on the state budget. To this end, there is a need to create capacity in the form of services that follow market-based rules, the main purpose of which is to facilitate renovation of apartment buildings, increase the number of rental houses and reduce the fluctuation of construction market volumes in time (counter-cyclical measure). According to one possible scenario, for all the needs pointed out in this strategy to be covered, the following estimated prerequisites should be met:

- The annual financing needs will be around €220 M in the first years. The state should cover around one-tenth of the amount.
- The total financing need until 2050 for renovating apartment buildings and constructing new buildings would be 7.9 billion euros. The financing needs may change depending on the adoption of new technologies, the market's adjustment to increased renovation volumes, etc.
- The state will get back around 30% of the construction costs as taxes, i.e. the related tax revenue would be 70-170 M euros a year.

In the case of **apartment building renovation,** these services could be used to offer loans, guarantees and counselling services in combination with existing measures applied by KredEx Foundation. Guarantees and guarantees in combination with long-term loans could be offered as financial measures. Upon applying a 3% interest rate, the annual loan payment would reduce by about a quarter in the case of annuity payments if the term of the loan is extended from 20 years to 30 years. Thus, a longer loan term would be comparable to offering financial support, even though it would not reduce the total cost (interest payments would ultimately be even larger).

All of the required preparatory work – mapping of the apartment association's wishes, offering solutions and organising the designing and construction process – can also be treated as a support measure. The organisational side is a significant obstacle to getting started with renovation.

[45] Ministry of Finance. 2019. https://blogi.fin.ee/2019/07/kohalike-omavalitsuste-finantstervis-on-hea/

All of the required preparatory work made by the buildings – mapping of the apartment association's wishes, offering and promoting solutions (together with the estimated savings) and organising the designing and construction process – can also be treated as a support measure. The organisational side is a significant obstacle to getting started with renovation. The KredEx Foundation as an external party and renowned competence provider with references could reach an agreement with apartment association members more quickly upon explaining the need for renovation work and possible solutions.

Construction of **rental buildings** in areas where new apartment buildings are not built on market terms. Considering the increasing mobility of people and changes in needs throughout the life cycle, renting allows for a greater flexibility in choices. Increasing the offering of rental houses with the help of KredEx Foundation's new services is also important for smoothing construction market fluctuations. While demand can be increased to a certain degree by renovating apartment buildings, in difficult times, it is more easier to support the construction volumes by building rental houses. Renovation of apartment buildings may be more cost-effective during a market slump (work costs less), but the readiness of apartment association members to commence with work may be hampered by the uncertainty of their financial situation and income.

11 Annexes

11.1 CO_2 emission reduction-based support measure for renovating commercial properties

In the example, calculation of a CO_2 emission reduction-based support measure is provided for office, commercial and service buildings. The calculation example is prepared on the basis of the average indicators for the energy use and renovation costs of buildings. Basic data for calculation:

- Electricity cost €100/MWh, heating cost €60/MWh
- Electricity has a specific emission factor of 0.83 t CO_2/MWh and heating 0.12 tCO_2/MWh.

The calculations proceed from the assumption that energy class C is achieved as a result of renovation.

Table 28. Changes in the energy use, CO_2 emissions and energy costs of office, commercial and service buildings.

Office	**Before renovation**				**Reduction after renovation**			
Building area, m^2	Heating, kWh/(m^2y)	Electricity, kWh/(m^2y)	CO_2, t/y	Energy cost, €/y	Heating, %	Electricity, %	CO_2, t/y	Energy cost, €/y
1,000	140	80	83	16,400	50%	44%	46	7,700
3,000	130	70	221	44,400	46%	36%	137	18,300
5,000	110	70	357	68,000	36%	36%	229	24,500
Commerce and services	**Before renovation**				**Reduction after renovation**			
Building area, m^2	Heating, kWh/(m^2y)	Electricity, kWh/(m^2y)	CO_2, t/y	Energy cost, €/y	Heating, %	Electricity, %	CO_2, t/y	Energy cost, €/y
1,000	80	140	126	18,800	31%	39%	77	7,000
3,000	80	140	377	56,400	31%	39%	231	21,000
5,000	80	140	629	94,000	31%	39%	386	35,000

The question of return on investment is important to property owners. The proportion of the support should ensure a payback period of more than 20 years.

Table 29. Investments required for renovating office, commercial and service buildings and payback period.

Office	**Investment**			**Ordinary payback period**			
Building area, m^2	Investment, €/m^2	Investment, €	Investment for reducing CO_2, €/t CO_2	Without support	Support, 30%	Support, 40%	Support, 50%
1,000	400	400,000	8,700	52	36	31	26
3,000	300	900,000	6,600	49	34	30	25
5,000	250	1,250,000	5,500	51	36	31	26
Commerce and services	**Investment**			**Ordinary payback period**			
Building area, m^2	Investment, €/m^2	Investment, €	Investment for reducing CO_2, €/t CO_2	Without support	Support, 30%	Support, 40%	Support, 50%
1,000	400	400,000	5,200	57	40	34	29
3,000	300	900,000	3,900	43	30	26	21
5,000	250	1,250,000	3,200	36	25	21	18

In the case of the renovation options given in the example, the support for an investment made in order to reduce one tonne of CO_2 emissions

could be between €1,000-2,600 at a support rate of 30%, €1,300-3,500 at a support rate of 40% and €1,600-4,400 at a support rate of 50%.

11.2 Measures related to renovation of existing buildings

This chapter provides an overview of measures related to buildings that underwent renovation in 2019. The measures are presented by institutions carrying out the measures.

Environmental Investment Centre

- Replacement of an apartment building's heating unit that runs on biomass or fossil fuel or a heating unit that partially uses electrical heating with a heating unit that uses renewable fuel or connecting an apartment building with the district heating network.
- Installation of local heating to replace the district heating system of an existing building and demolishing the parts of the district heating system that falls into disuse as a result thereof.

SA KredEx

- Housing loan guarantee for purchasing a new home or renovating an existing one.
- Renovation support for small houses for improving their energy performance.
- Home support for families with many children, who can use the support to purchase, construct, expand or renovate their home.
- Loan guarantee for apartment associations for financing renovation-related work.
- Renovation support for conducting full renovation.
- Electrical system renovation support for buildings in Tallinn that use the old voltage system with the purpose of changing the buildings over to the new voltage system.
- Solar panel investment support for apartment associations, companies and local governments.
- Demolition support for local governments for demolishing residential buildings and non-residential buildings that have fallen into disuse.

State Shared Service Centre

- Support for improving the energy performance of central-government buildings in order to renovate an existing building or building a new building to replace an existing one.
- Support for making local government buildings energy efficient.

11.3 Results of interviews conducted among owners of private sector non-residential buildings

In the course of preparing the strategy, interviews were conducted with six representatives of companies owning and developing commercial properties and representatives of the Estonian Association of Construction Entrepreneurs. The purpose of the interviews was to determine the conditions on which owners of commercial properties decide to invest in energy savings-related renovation.

The functioning logic of the commercial property market is not conducive to full renovations, because the tenant covers the main costs, of which only a fraction are energy costs. Conscious tenants are more interested in interior climate rather than energy performance. There are also investors who keep buildings in their portfolio for a short period of time. As there is no intention of using the building for the long-term, the investor does not deem it necessary to invest in improving the building's condition.

It is known that buildings age in 30 years and property owners are forced to upgrade their buildings in order to stay on the market. The question is, in what extent will renovation work be undertaken? Larger projects with a payback period of over 20 years are not attractive to owners, because by then the building services systems installed will need to be replaced again. The investment payback period should be less than 10 years.

As the return on investments made is important in the case of renovations, property owners have to be informed and require specific and realistic savings in order to make decisions. Assessments on the possibilities of saving energy and full renovation plans prepared by specialists would help to achieve this.

In the case of commercial properties that are located outside of centres, tenants do not have much of a choice in terms of rental spaces and do not therefore have any particular demands in relation thereto. Additionally, areas outside centres lack energy performance-related awareness and the capability to carry out full renovation projects.

The main problems commercial property owners face when renovating are as follows:

- long investment payback period;
- investment is made by the property owner, while the tenant benefits;
- the reduction in energy costs achieved as a result of renovation may not be attractive to tenants;
- energy performance requirements are changing too fast. Requirements that are constantly amended and changes in calculation methodology (e.g. changes in weighting factors) make preparing a long-term view more difficult. Future energy performance requirements for buildings are unknown.

- Full renovation requires temporary closure of the building, which reduces the property owner's rental income.
- The construction company carrying out the construction or renovation work is not interested in future use of the building and its operating costs.

Solutions proposed by owners of commercial properties:

- Planned changes in building energy performance requirements must be announced as early as possible. Property owners would like to know the changes to be introduced in the building energy performance regulations and the implementation time of the new requirements at least 10-20 years in advance.
- The energy class boundaries must be stable. A system where energy class boundaries change every five years is too unstable to base investment decisions on. A building energy performance assessment system that is more stable and easier for the public to understand.
- In the case of energy savings support, a requirement to prove the achievement of the energy savings goal must be added to the support measure. For instance, achievement of the goal must be proved a year after the completion of the renovation work.
- Carrying out commercial property renovation pilot projects to demonstrate best practices.
- More attention should be paid on IT solutions of buildings: automation, remote management, troubleshooting, monitoring of use profiles and building services system monitoring.
- Energy audits should be more detailed and renovation work proposed therein should consider the feasibility and additional costs of the work.
- Preparation of an energy consumption survey of the commercial property sector. For instance, preparing an additional query to property owners about the energy consumption of properties owned by them. This can be used to obtain an overview of existing buildings.

11.4 Public consultation and inclusion of stakeholders in the preparation of the strategy

In order to include and inform stakeholders, two workshops were organised in the rooms of and at the invitation of the Ministry of Economic Affairs and Communications. The first workshop on 10 December 2019 focused on the condition of residential buildings and possible measures. 44 people from 23 organisations participated in the workshop, which indicates a great interest in renovating apartment buildings and small residential buildings.

The second workshop on 19 February 2020 addressed market-based renovation of non-residential buildings, market failures and possible measures. 26 people from 22 organisations participated in the workshop.

The workshops provided important feedback and also proposals. The most important of these are:

- reflecting the need to develop new buildings outside Tallinn, Tartu and Pärnu in order to set off the buildings that fall into disuse and are likely demolished in the strategy;
- imposition of energy class C requirement on all spaces used by the public sector;
- considering factors other than energy savings when renovating buildings (building accessibility, building safety, the shrinking of cities).

Five steering group meetings were held when preparing the strategy: on 26 September 2019, 21 October 2019, 13 November 2019 and 19 February 2020. The steering group involved the representatives of the Ministry of Economic Affairs and Communications, the Ministry of Finance, the Ministry of the Environment, KredEx Foundation, State Real Estate Company Riigi Kinnisvara AS, the Estonian Environmental Research Centre and Tallinn University of Technology.

The strategy was introduced to a wider audience at the Ehituse Treff 2019 event on 5 December 2019 (110 participants) and the round table on housing on 29 January 2020 (80 participants).

11.5 Methodology for estimating residential building volumes.

In the next few decades, renovation needs will be shaped by demographics and migration. It is not practical to renovate buildings in areas that are shrinking and where buildings will fall into disuse in the future. According to the population projections of Statistics Estonia, the Estonian population is decreasing (statistics tables RV086, RV088 2019).

The renovation volume of buildings that fall into disuse is estimated on the basis of the basic population projection scenario (RV086), which Statistics Estonia considers the most likely. More positive and negative scenarios have not been used in calculations of building abandonment rates, because 1) these are less likely and 2) Statistics Estonia has not prepared a population projection by county for these scenarios.

Migration, which follows global trends, is much more important than population dynamics in the context of buildings falling into disuse. The main trend is the continuation and acceleration of the urbanisation process. This means that the periphery empties and larger centres grow on the account of rest of the areas. This in turn increases the housing need in centres and contributes to the emptying of residential buildings in other areas. In Estonia, urbanisation is mainly expressed in the movement of people to larger centres with well-paid jobs. These centres are the urban areas in mainly Harju County and, to a smaller extent, Tartu County. Population is in decline in other regions. The population projections of Statistics Estonia take migration into account. Thus, if a more positive demographic scenario becomes a reality, the population grows and the share of external migration increases, it is still of marginal importance compared to the impact of urbanisation.

Considering 1) the research volume, 2) availability of existing data and 3) the need for the strategy to be precise, the volume of buildings was projected using the distribution of functional regions by Statistics Estonia as the regional population density system model (Statistics Estonia 2014). The distribution of functional regions is based on commuting data, which characterises the link between population distribution and destinations that are mainly related to work and study. Estonia is divided into functional regions with one centre. This mainly

coincides with the county centre, but in several counties additional centres have occurred as a result of migration. All of the hinterlands of the centres of functional regions are divided into three zones: immediate hinterland, transition zone and periphery. The zones of a functional region correlate well with other regional development indicators, such as the transaction value of apartment buildings, which is why it is appropriate to use the functional region model in the renovation strategy.

In addition to centres of functional regions, the analysis also discerns second-tier centres and other urban areas in accordance with the 2019 small settlements study.

Data, prerequisites and methods

1. Data related to residential buildings originate from the Building Registry; KredEx Foundation renovation database; the public database of 2000 and 2011 population and housing census; the transaction value register of the Land Board; the database of 2019 small settlements study; public databases of Statistics Estonia.
2. The population projection by counties prepared by Statistics Estonia until 2045 is, within the context of the study, linearly extended by five years to bring it in line with the target deadline of 2050 of the renovation strategy.
3. When estimating the housing abandonment rate it is presumed that upon shrinking of regions, residential buildings fall into disuse on the basis of the following regional hierarchy: the periphery of functional regions will empty first, followed by transitional areas. In some regions (e.g. Ida-Viru County and Valga County), where there are fewer residential buildings outside centres, but the population projection indicates a decrease, residential buildings fall into disuse also in centres.
4. The ratio of residents of apartment buildings and small residential buildings is determined by urban areas using public statistics from Statistics Estonia. Even though the population and housing census enables the distribution of residents of each building to be determined on the basis of the building type, such an approach was not practical considering the volume of the analysis and the need for the strategy to be precise.
5. Upon analysing the abandonment rate of residential buildings, it is presumed that most of the impact of the decrease in population is expressed in the emptying of apartment buildings. Small residential buildings may also remain in seasonal use in the periphery. Apartment buildings in sparsely populated regions, e.g. apartments of former Soviet agricultural holdings, however, fall into disuse.

6. The abandonment rate of residential buildings in functional regions is determined on the basis of urban areas taking into account 1) the number of small residential buildings and apartment buildings and 2) the area per residents.
7. The paper assumes that private houses that are no longer in permanent use may remain in seasonal use and are not generally demolished. Demolition is unavoidable in the case of emptying apartment buildings at least in urban centres.
8. Housing abandonment is not a linear process. It is presumed that abandonment is likely exponential and cyclical. Housing abandonment cycles are likely linked to economic cycles, which have not been forecasted in the current work.