



**SUNShINE**  
SAVE YOUR BUILDING  
BY SAVING ENERGY



## Deep renovation of multifamily residential buildings ANALYSIS OF CASE STUDIES

# Table of content

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<b>ABOUT SUNSHINE .....</b>	<b>3</b>
<b>INTRODUCTION .....</b>	<b>3</b>
<b>ENERGY EFFICIENCY MEASURES AND PHYSICAL IMPROVEMENTS TO THE BUILDINGS.....</b>	<b>4</b>
<b>ANALYSIS OF CASE STUDIES.....</b>	<b>6</b>
<b>COMPARING THE RESULTS OF RENOVATION PROJECTS .....</b>	<b>8</b>
<b>ANNEX .....</b>	<b>11</b>
<b>CASE STUDY 1: GAUJAS STREET 13 .....</b>	<b>12</b>
<b>CASE STUDY 2: KOVARNU STREET 31.....</b>	<b>14</b>
<b>CASE STUDY 3: SAULES STREET 17B.....</b>	<b>16</b>
<b>CASE STUDY 4: VIESTURA STREET 8A .....</b>	<b>18</b>
<b>CASE STUDY 5: VIESTURA STREET 10A.....</b>	<b>20</b>
<b>CASE STUDY 6: VILKU STREET 5 .....</b>	<b>22</b>
<b>CASE STUDY 7: ZIRNU STREET 21 .....</b>	<b>24</b>
<b>CASE STUDY 8: STACIJAS STREET 28 .....</b>	<b>26</b>
<b>CASE STUDY 9: KAIJAS STREET 6.....</b>	<b>28</b>
<b>CASE STUDY 10: MASTU STREET 8/1 .....</b>	<b>30</b>

## Editorial information

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## About SUNShINE

Deep renovation – the idea of capturing the full economic energy efficiency potential of existing buildings with focus on building envelopes – leads to remarkable energy savings. As nearly all of Latvia's stock of multifamily residential buildings continues to rapidly deteriorate due to harsh weather conditions and lack of proper maintenance, the idea is attractive.

SUNShINE supports public and private Energy Service Providers' and leads to an innovative investment scheme with a pipeline of 2020m<sup>2</sup> of deeply renovated buildings. A major objective is to demonstrate the financial viability of deep renovation via suitable financial engineering of public funds and private capitals.

## Introduction

The vast majority of existing multi-family buildings in Latvia, and Eastern Europe in general, has not undergone any major energy conservation improvements and has the same energy infrastructure as when they were built. That was a time when energy was virtually a free commodity.

Multi-family buildings in Latvia consume 50%-60% more energy than necessary. During the heating season costs for heating and hot water preparation account for more than 70% of total housing maintenance costs.

Average consumption of heat in buildings in Latvia ranges from 200-250 kWh/m<sup>2</sup>/year. Today in countries with similar climate conditions as Latvia, such as Sweden, average consumption of heat in buildings is in the range of 110-130 kWh/m<sup>2</sup>/year. Today, in Latvia is possible to build building with energy consumption below 50 kWh/m<sup>2</sup>/year.

Latvia currently spends almost half a billion Euro a year to heat residential buildings. Often the residents are paying high energy bills and still receiving unsatisfactory services: low temperatures in rooms, cold walls, draft and moisture and mold problems. All of this is because of poor building energy efficiency and maintenance.

Deep buildings renovations based on Energy Performance Contracting (EPC) can help to solve this outstanding problem. The EPC is typically twenty years of guarantee energy savings, which are used to repay investments and maintain the buildings.

A deep renovation extends the lifespan of the building and therefore provides a valuable socio-economic service to society and to the residents-owners; insulating the building keeps the buildings dry and protected from weather conditions thereby prevents further decay and corrosion of the building envelope; replacing non-insulated, calcified and corroded iron piping guarantees the safety and continued functioning of the internal networks. After a full and proper renovation these buildings will provide good living spaces for their families for at least another 20-30 years and probably longer. The value of the energy that is saved is the basis of the business model, which pushes Energy Service Provides to be smart in every solution and energy efficiency measures that they will introduce in the buildings we renovate.

This report includes a collection of ten case studies, where each renovation project is described from a technical and economic stand point of view. The report includes a comparative analysis of the case studies including a benchmark analysis on achieved energy savings, renovation costs and payment levels.

## Energy efficiency measures and physical improvements to the buildings

The building envelope refers to the basement, walls, windows, doors and roof of a building. It plays the leading role in the energy losses of a structure. The remaining energy is lost through gaps and vents in the fabric, which allow warm air to leave and cold air to enter the space (either deliberately through ventilation or uncontrolled through gaps and cracks).

This energy lost has to be supplied by the heating system. The rate at which heat is supplied depends on:

- The temperature difference between the inside and outside of the building;
- The insulation properties of the building envelope;
- The amount of fresh air entering the building either by controlled ventilation or through poorly fitting windows doors or joins in walls.

In the proposed case studies the energy performance of existing building has been significantly improved by:

- improving the insulation properties and air tightness of the building envelope;
- controlling indoor air temperature;

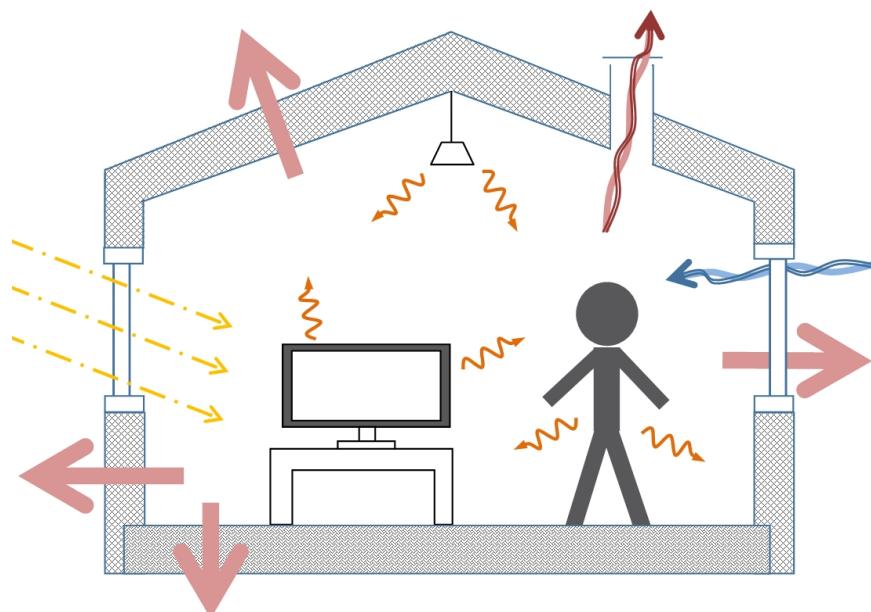
- regulating the amount of fresh air entering the building.

The renovation measures can roughly be split into the following categories:

1. Preventing heat loss out of the building fabric:
  - adding an additional outer wall layer of insulating material;
  - replacing windows and entrance doors;
  - insulating the attic floor and the basement ceiling.
2. Preventing losses in circulating heat and hot water systems through the building;
  - insulating and decreasing the length and volume of the heating network;
  - decommissioning the current hot water networks which are highly inefficient, typically not well insulated, over-dimensioned, calcified with a much shorter and small diameter pipe network.
3. Preventing overheating in apartments. Currently heat is often provided without any adjustment to solar radiation or heat produced by people through cooking, lighting, electronic devices (heat gains). Therefore, often residents open the windows to let out excess heat. The following measures not only save

energy, but make the overall climate in the building more comfortable:

- installing thermostatic regulators on all radiators;
- installing monitoring system measuring temperature in the apartments to adjust total heat delivery to the building based on real demand.
- 4. Preventing losses from the ventilation system. Ventilation of a building provides fresh air and removes contaminants generated inside buildings to ensure healthy indoor air quality. In most of the Latvian multifamily residential buildings, ventilation is achieved naturally and totally



- uncontrolled. This is a main source of energy losses.
5. Repairs or improvement to halt and prevent structural problems caused by corrosion. These problems can also cause unnecessary energy losses and, if not treated in time, can lead to serious problems with the building's functioning during the contract period:
    - repairing cracks in walls and foundation;
    - repair of roofs (almost all buildings require major reconstruction works of their roofs);
    - hydro insulation of basement to protect against rainwater entering the basement and foundations.
  6. Improvements to the looks, comfort and overall impression of the building which can best be done as part of the overall renovation:
    - renovation of the staircases and entrances;
    - repairing, removing or replacing of balconies (might also be necessary due to safety issues);
    - Other improvement such as installing sensor lighting in halls, installing automatic door openers, repairs of cold water networks, etc.



## Analysis of case studies

The following buildings have been deeply renovated in recent years:

- 13 Gaujas Street, Valmiera
- 31 Kovaru Street, Cesis
- 17B Saules Street, Cesis
- 8A Viestura Street, Cesis
- 10A Viestura Street, Cesis
- 5 Vilku Street, Cesis
- 21 Zirnu Street, Cesis
- 28 Stacijas Street Sigulda
- 6 Kaijas Street, Sigulda
- 8/1 Mastu Street, Riga

Before renovation these buildings were consuming on average 156 kWh/m<sup>2</sup> year for space heating and 42 kWh/m<sup>2</sup> year for network circulation losses, meaning a total consumption of 198 kWh/m<sup>2</sup> year. On top of this, 24 kWh/m<sup>2</sup> year were used on average for domestic hot water preparation.

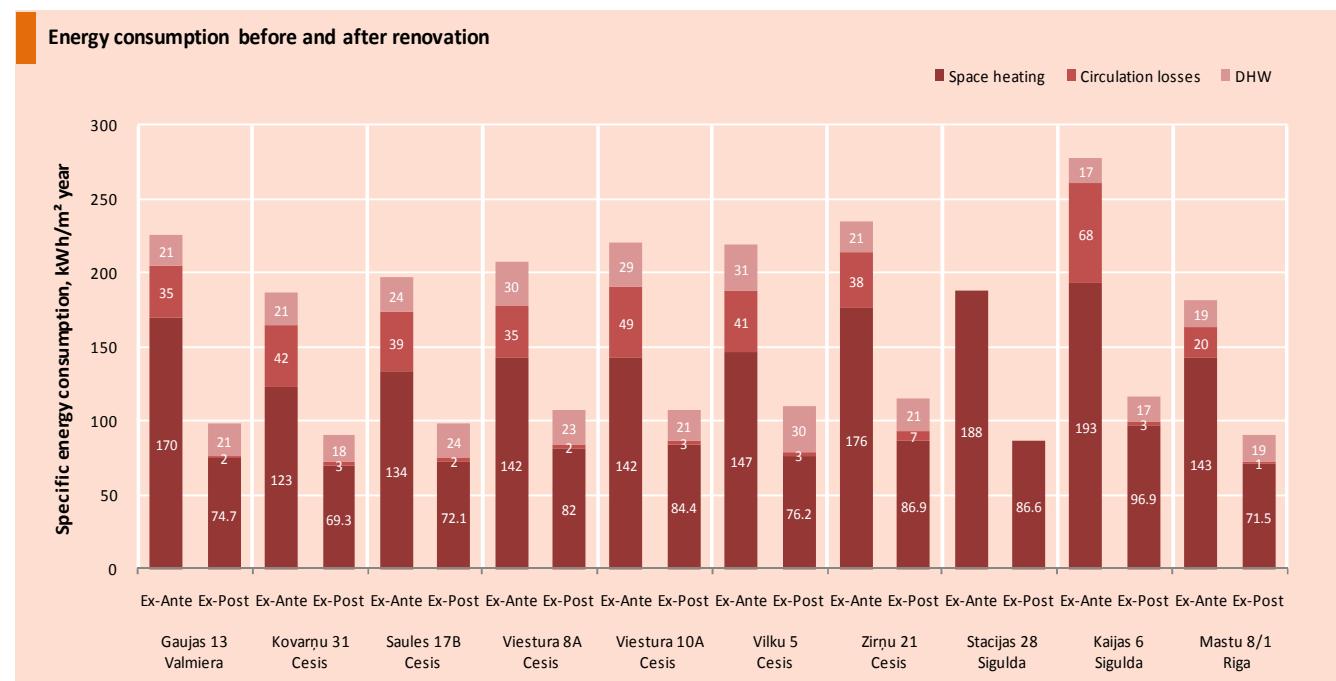
The ex-post energy consumption of these buildings has been significantly reduced. Now based on 2014 data, on average space heating consumption is down to 77 kWh/m<sup>2</sup> year and network circulation losses is down to 2.3kWh/m<sup>2</sup> year, meaning a combined figure of 79.3 kWh/m<sup>2</sup>year. Then 22 kWh/m<sup>2</sup>year are used by tenants for domestic hot water preparation (see chart).

Compared to the ex-ante figures, the energy savings of the renovated building stock for space heating and circulation losses are calculated at **58%**. This corresponds to total energy savings of more than **2000 MWh/year**, avoiding more than **550<sup>1</sup>** tCO<sub>2</sub> emission per year.

Energy savings are calculated based on available metered data normalized to normal degree days as prescribed by the Latvian

building code.

These outstanding results have been achieved thanks to the deep renovation of these buildings. The cost of renovation varied from 90 €/m<sup>2</sup> to 147 €/m<sup>2</sup> (ex-VAT) depending from the year of renovation, building type and the technical conditions before renovation (see chart next page). Of these costs about 9% to 25% were spent for the implementation of important repairs measures on foundation,

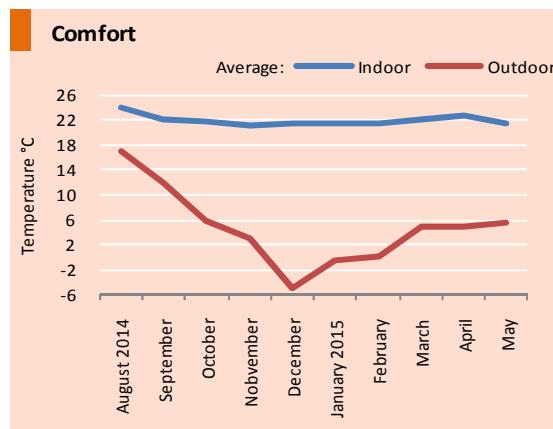


roof, balconies, staircases and entrance halls, which are not directly linked to energy savings.

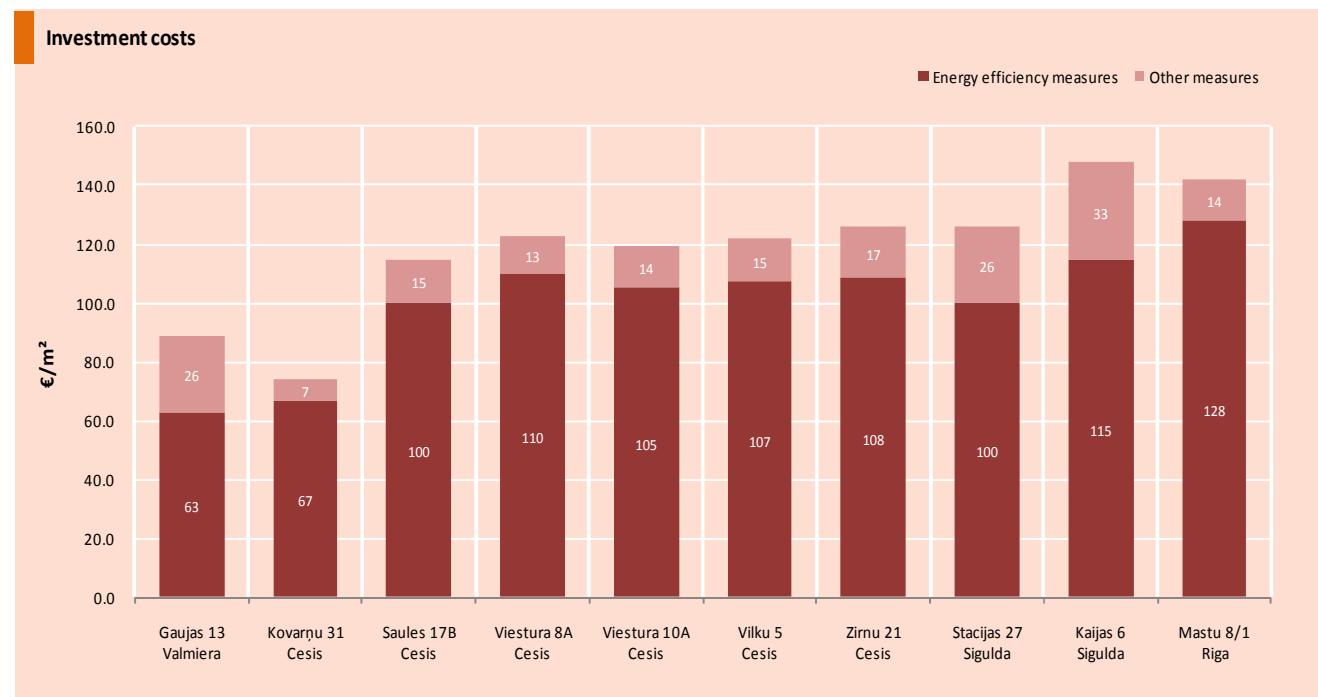
The current benchmarks are now higher, due to stricter building codes and general inflation, meaning between 150 €/m<sup>2</sup> to 180 €/m<sup>2</sup> (ex-VAT).

The comfort level is an important aspect of a deep renovation project, and energy savings should not be the result of under heating.

The buildings analyzed in this report are continually monitored. And temperature sensors are installed in several flats measuring indoor air temperature. Data from the last heating seasons showed an indoor temperature slightly above 21.5°C.



As annex to this report more data are available for each of the building.



## Comparing the results of renovation projects

Valmiera is one of the oldest towns in Latvia, which is located about 120 km northeast from Riga and about 50 km from the border of Estonia.

This case study compares the energy performance of three buildings located in Gaujas Street:

- 9 Gaujas Street
- 11 Gaujas Street
- 13 Gaujas Street

### General Building Data

These buildings belong to the very common 467th type building series made from prefabricated concrete slabs. 13 Gaujas Street was built in 1980, 11 Gaujas Street in 1979 and 9 Gaujas Street in 1977. They all are nine storey buildings with a single staircase. The average height of one storey is 2.5 m; the total surface area is about 2165m<sup>2</sup>, of which about 1900 m<sup>2</sup> are heated in winter. All three buildings have 36 apartments. Heat supply to the building is provided by the local district heating company. Maintenance services are provided by the municipal house maintenance company.

An ESCO company, via an energy performance contract (EPC), has performed deep retrofitting of 13 Gaujas Street. Under this EPC, the ESCO guarantees the building's energy performance (energy savings) and the level of payments. All financial and technical risks were taken by the ESCO. The project was financed by the ESCO, with third party financing and a grant from the Latvian ERAF support programme.

The home owners of 11 Gaujas Street organised the renovation works for their building themselves with the support of the municipal housing maintenance company. They used the same contractors used by the ESCO in 13 Gaujas Street for construction and plumbing works. Gaujas 11 was financed with a loan from a commercial bank and also received a grant from the Latvian ERAF support programme.

The home owners of 9 Gaujas Street did not agree to implement any renovation project.

All buildings are located in the same street on the banks of Gaujas River, meaning subject to the same weather conditions and solar gains.



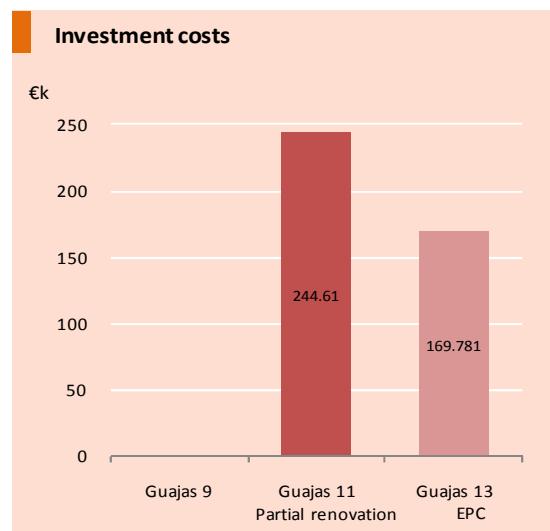
### How Much Did the Renovation Cost?

The renovation of 13 Gaujas Street, which was organised by an ESCO under an EPC, cost about €170k. With this investment the ESCO renovated the building envelope, the space heating system, the heat substation and installed a new domestic hot water system. Other important structural measures were implemented, such as the roof refurbishment. As part of the same renovation process the staircase and balconies were renovated. The ESCO supervised all construction and installation works.

The renovation of 11 Gaujas Street, which was organised by the home owners, cost €225k, according to the contractor, who carried out the work on both MFBs. The renovation plan was similar to the plan used by the ESCO in 13 Gaujas Street. However, some energy efficiency improvement measures were not implemented, for example

the installation of a new domestic hot water system and the installation of thermostatic radiator valve.

The building in 9 Gaujas Street was not renovated at the time of this study.



The renovation in Gaujas 11 was about 32% (approx. EUR 55.000) more expensive than the renovation based on energy performance contracting made in Gaujas 13; this although less energy efficiency improvement measures were implemented in Gaujas 11. The building in Gaujas 11 was renovated one year later than Gaujas 13, also meaning that partly a cost increase is justified by inflation in the

building construction industry. However, the other more relevant reason is more the ability of EPC provider to professionally deal with contractors.

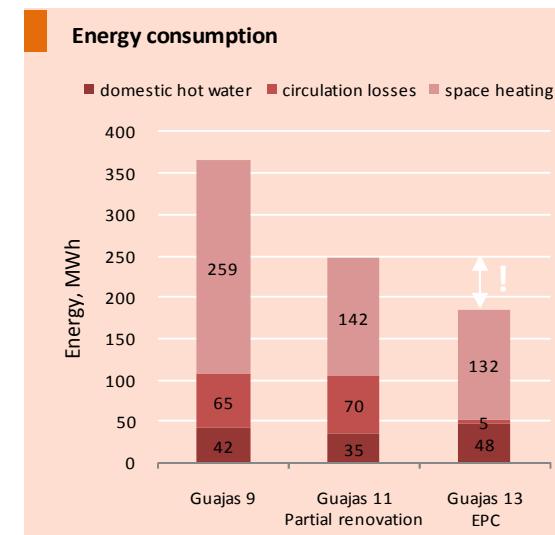
### How much energy do they save?

The district heating company of Valmiera supplies energy to these three buildings. Heat energy is metered at the building substation. Energy performance of these three building is assessed by comparing the total energy consumption for 2013.

As expected 9 Gaujas Street, which was not renovated, is the most energy consuming building. Total annual energy consumption is 366 MWh (202 kWh/m<sup>2</sup> per year), of which about 42 MWh for domestic hot water (DHW) preparation and 65 MWh for circulation losses. This is an indicative benchmark of the pre-renovation consumption figures for 11 and 13 Gaujas Street.

11 Gaujas Street, which was renovated by the home owners, has a total annual energy consumption of 247 MWh (134 kWh/m<sup>2</sup> per year), of which about 35 MWh for domestic hot water preparation and 70 MWh for circulation losses.

13 Gaujas Street, which was renovated by an ESCO via an EPC, has a total annual energy



consumption of 185 MWh (96 kWh/m<sup>2</sup> per year), of which about 48 MWh for domestic hot water preparation and 5 MWh for circulation losses.

Based on these figures, Gaujas 13 is saving 38 kWh/m<sup>2</sup> per year more than Gaujas 11 while at the same time investment costs were 32% less.

### What about residents' bills?

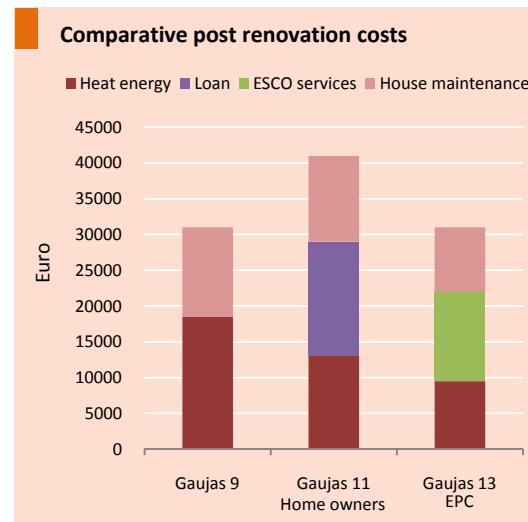
Comprehensive and deep renovation protects, followed by proper maintenance of buildings extends their life by 30 years or more. However, this must be financially affordable

for residents, who will keep paying communal services, loans and utilities bills.

In Gaujas 13 the residents are not required to repay any loan because financing was arranged by the ESCO; instead they will pay a fee, based on the clauses agreed in the EPC, which includes both heat energy costs and ESCO services. Moreover, the ESCO will keep operating and maintaining all investments made in the building for the entire duration of the Energy Performance Contract (20 years). As the ESCO takes over part of the maintenance duties from the house maintenance company, the house maintenance fee is renegotiated and lowered. In 2013, the residents of Gaujas 13 paid a total bill of EUR 30,850 for house maintenance and ESCO services including energy costs. A guaranteed temperature of 21.5°C was kept throughout the winter season.

In 2013, the residents of 11 Gaujas Street paid a total bill of about EUR €40,600; this covered house maintenance costs, the loan and energy costs. The renovation was financed with a 15 year loan with an interest rate of 4.5% + 3 months Euribor.

In 2013, the residents of Gaujas 9 paid a total bill of about €31,500; for house maintenance services and energy costs.



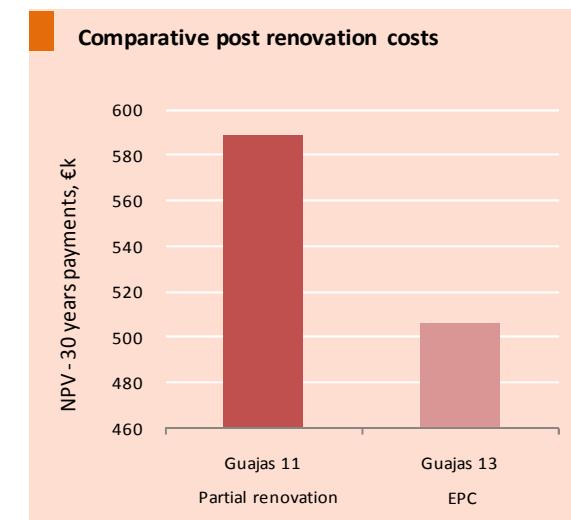
### What about the long term; in 30 years' time?

The deep renovation of the building 13 Gaujas Street will extend its life for at least 30 years. Therefore, the residents' payments have to be evaluated in this time period. In particular, the net present value of all future payments is a good indicator for comparing the three buildings under evaluation.

The following data set and assumptions are used:

- Inflation 3%
- Discount rate: 6.5%
- 11 Gaujas Street:

- Loan maturity 15 years
- Interest rate: 4.5%+ Euribor
- 13 Gaujas Street:
  - 20 year EPC,
  - Indexed to energy inflation



The residents of 9 Gaujas Street, without renovation, at a certain point in time will have to look for new housing, with major investment costs. In the meantime their comfort and quality level is significantly less and continues to deteriorate. Additionally they will face the costs and inconvenience of ever more expensive emergency repairs over the coming years.

## ANNEX

This annex includes information about the following case studies:

- 13 Gaujas Street, Valmiera
- 31 Kovarnu Street, Cesis
- 17B Saules Street, Cesis
- 8A Viestura Street, Cesis
- 10A Viestura Street, Cesis
- 5 Vilku Street, Cesis
- 21 Zirnu Street, Cesis
- 28 Stacijas Street Sigulda
- 6 Kaijas Street, Sigulda
- 8/1 Mastu Street, Riga



## Case study 1: Gaujas Street 13

### The building

This building belongs to the 467 standard type building and it was built in 1980. It is a nine storey building with a single staircase. The average height of one storey is 2.5 m; the total surface area is 2239 m<sup>2</sup>, of which 1914.6 m<sup>2</sup> are heated in winter. There are 36 apartments in the building.

### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (10 cm mineral wool panels), of the attic (20 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the replacement of the heat substation, the installation of thermostatic valves and the replacement of the main heat distribution pipes in the basement and attic. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design, including minimized number of risers using pre-insulated pipes.

The building was equipped with an energy monitoring system.



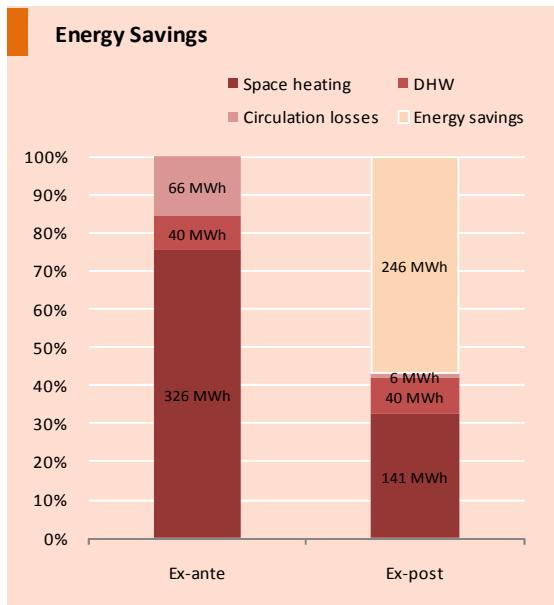
Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated and partly reconstructed, the staircases were refurbished and repainted and the loggias were renovated.

### The investment

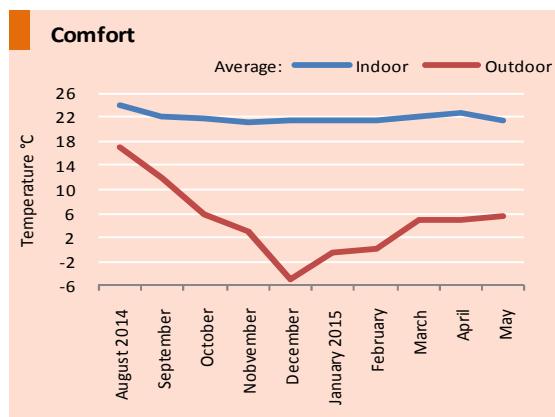
Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation		3,820 €	3,820 €
Insulation of walls	42,490 €		42,490 €
Insulation of cellar ceiling	3,560 €		3,560 €
Insulation of attic	3,750 €		3,750 €
Replacement of windows	17,840 €	3,390 €	21,230 €
<b>Engineering</b>			
Heat substation	4,860 €		4,860 €
Space heating system	17,300 €		17,300 €
Domestic hot water system	17,870 €		17,870 €
Cleaning ventilation shafts		2,180 €	2,180 €
Monitoring system	4,270 €		4,270 €
<b>Other renovation measures</b>			
Roof renovation		2,760 €	2,760 €
Staircase		15,240 €	15,240 €
Entrance halls		1,370 €	1,370 €
Balcony		14,020 €	14,020 €
Other costs	8,520 €	6,550 €	15,070 €
<b>Total</b>	<b>120,460 €</b>	<b>49,330 €</b>	<b>169,790 €</b>

### The energy savings and comfort

After completion of the construction works, the results are closely monitored. The analysis of the collected data showed energy savings for space heating of 56.7% and a 91.7% reduction of the circulation losses for the domestic hot water system. In total, energy saving summed up to 62.7%, which in absolute terms equals to energy savings of 246 MWh or 64.9 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.



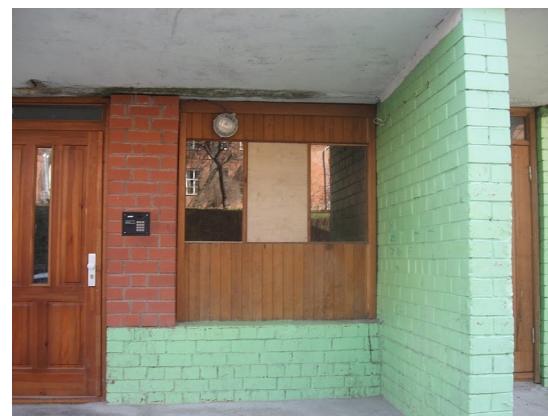
The comfort level is an important aspect of the project and indoor temperature is guaranteed by the ESCO. This is monitored and maintained at around 21.5°C in all heating season.



**Before renovation**



**After Renovation**



## Case study 2: Kovarnu Street

### 31

#### The building

This building belongs to the 103 standard type building and it was built in 1975. It is a five storey building with five staircases. The average height of one storey is 2.5 m; the total surface area is 4943.70 m<sup>2</sup>, of which 3750 m<sup>2</sup> are heated in winter. There are 70 apartments in the building. This 103 building series type is typically characterized by severe problem of the brick exterior walls, which after several years of exploitation are weathered and cracked.

#### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (120 cm mineral wool panels), of the attic (25 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the installation of new boilers, the renovation of the space heating system with the installation of thermostatic valves and the replacement of the main

distribution pipes in the basement and attic. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design. Domestic hot water meters were installed in staircases.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated, the staircases were plastered and repainted, and the balconies were replaced with modern design loggias.

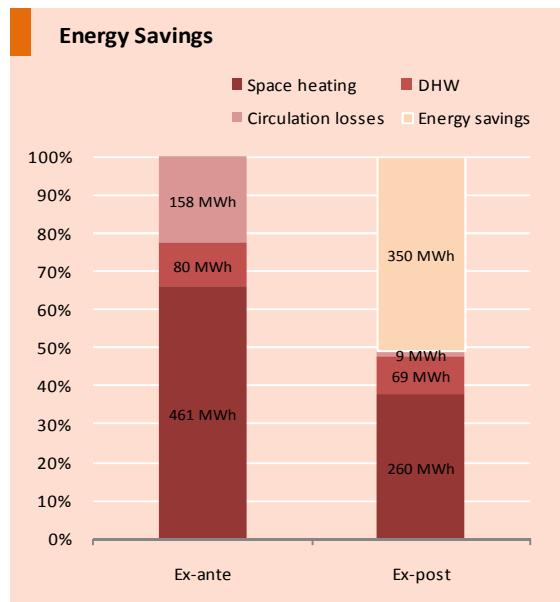
#### The investment

Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Insulation of walls	78 662 €		78 662 €
Insulation of cellar ceiling	9 532 €		9 532 €
Insulation of attic	8 633 €		8 633 €
Replacement of windows	74 330 €		74 330 €
<b>Engineering</b>			
Heat substation	5 834 €		5 834 €
Space heating system	37 923 €		37 923 €
Domestic hot water system	34 379 €		34 379 €
<b>Other renovation measures</b>			
Roof renovation	5 191 €		5 191 €
Staircase	13 725 €		13 725 €
Entrance halls	5 309 €		5 309 €
Other costs	2 355 €	941 €	3 296 €
<b>Total</b>	<b>251 648 €</b>	<b>25 166 €</b>	<b>276 814 €</b>



#### The energy savings and comfort

After completion of the construction works, the results are closely monitored. The analysis of the collected data showed energy savings for space heating of 43.6%. Circulation losses for the distribution of domestic hot water have been reduced by 94.3%. The total energy savings are then **56.5%**. In absolute terms this equals to energy savings of 350 MWh or 92.4 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.



The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider and it is monitored and maintained between the agreed levels, which around 21.5°C.

**Before renovation**



**After Renovation**



## Case study 3: Saules Street 17b

### The building

This building belongs to the 103 standard type building and it was built in 1976. It is a four storey building with three staircases. The average height of one storey is 2.5 m; the total surface area is 2510.80 m<sup>2</sup>, of which 1720.9 m<sup>2</sup> are heated in winter. There are 33 apartments in the building.

### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (100 mm mineral wool panels), of the attic (200 mm loose mineral wool), thermal insulation of the basement ceiling (100mm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the integration of a heat pump system with vertical geothermal probes, the renovation of the space heating system with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic. The domestic hot water circulation system was

fully reconstructed using a modern and new energy efficient design.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated, the staircases were plastered and repainted, the loggias were also refurbished.

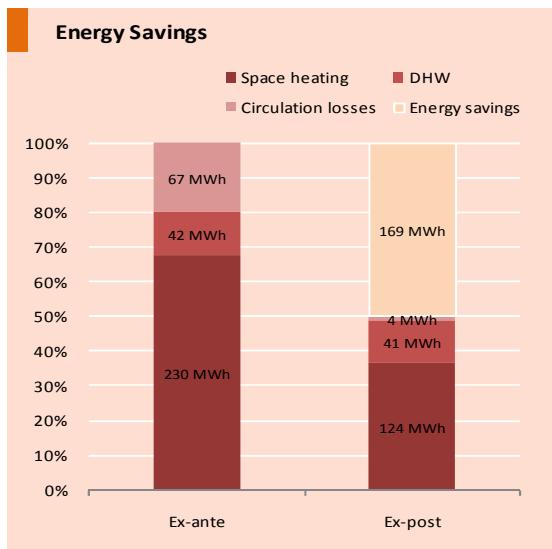
### The investment

Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation		1 451 €	1 451 €
Insulation of walls	59 470 €		59 470 €
Insulation of cellar ceiling	7 647 €		7 647 €
Insulation of attic	8 646 €		8 646 €
Replacement of windows	31 457 €		31 457 €
<b>Engineering</b>			
Space heating system	36 734 €		36 734 €
Domestic hot water system	22 957 €		22 957 €
Cleaning ventilation shafts		1 069 €	1 069 €
Monitoring system	1 885 €		1 885 €
<b>Other renovation measures</b>			
Roof renovation		311 €	311 €
Staircase		5 898 €	5 898 €
Entrance halls		4 549 €	4 549 €
Balcony		8 575 €	8 575 €
Other costs	3 415 €	3 499 €	6 914 €
<b>Total</b>	<b>172 211 €</b>	<b>25 353 €</b>	<b>197 564 €</b>

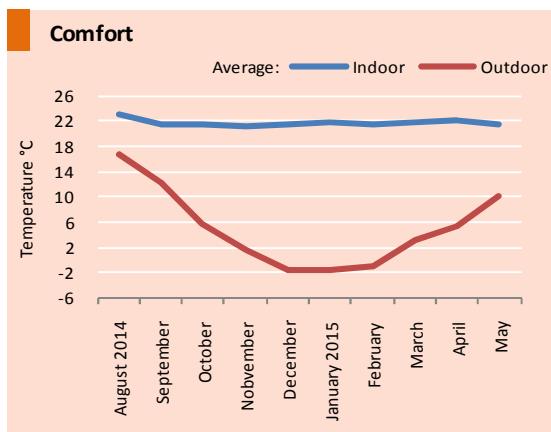


### The energy savings and comfort

The analysis of the collected data showed energy savings for space heating of 46.1% and a 93.8% reduction of the circulation losses for the domestic hot water system. In total, energy saving summed up to **56.8%**, which in absolute terms equals to energy savings of 169 MWh or 44.6 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.



The comfort level is also an important aspect of the project. The indoor air temperature in this project is guaranteed by the Energy Service provider and it is monitored and kept between an agreed range, around 21.5°C.



### Before renovation



### After Renovation



## Case study 4: Viestura Street

### 8a

#### The building

This building belongs to the 103 standard type building and it was built in 1983. It is a 4-5 storey with four staircases. The average height of one storey is 2.5 m; the total surface area is 4343.90 m<sup>2</sup>, of which 2535.80 m<sup>2</sup> are heated in winter. There are 45 apartments in the building.

#### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (10 cm mineral wool panels), of the attic (20 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the renovation of the space heating system with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated, the staircases were plastered and repainted, the loggias were also refurbished with modern shields.

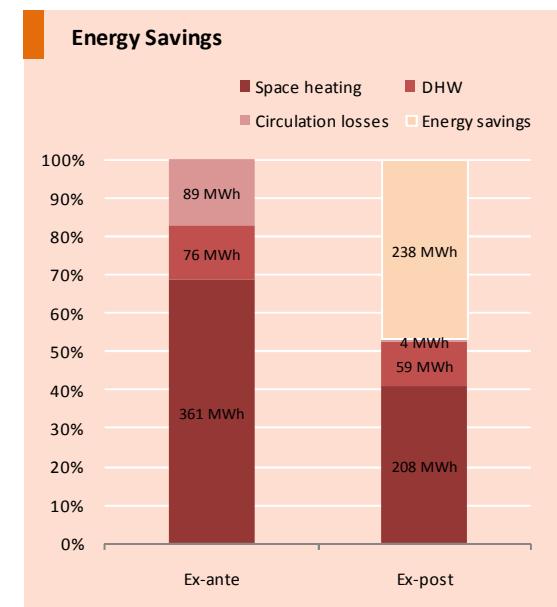
#### The investment

Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation	1 724 €	1 724 €	
Insulation of walls	99 983 €	99 983 €	
Insulation of cellar ceiling	10 945 €	10 945 €	
Insulation of attic	20 839 €	20 839 €	
Replacement of windows	41 893 €	41 893 €	
<b>Engineering</b>			
Space heating system	57 656 €	57 656 €	
Domestic hot water system	32 205 €	32 205 €	
Cleaning ventilation shafts	3 472 €	3 472 €	
Monitoring system	3 510 €	3 510 €	
<b>Other renovation measures</b>			
Roof renovation	394 €	394 €	
Staircase	10 077 €	10 077 €	
Entrance halls	2 402 €	2 402 €	
Balcony	18 920 €	18 920 €	
<b>Other costs</b>	<b>7 762 €</b>	<b>7 762 €</b>	
<b>Total</b>	<b>278 265 €</b>	<b>33 517 €</b>	<b>311 782 €</b>

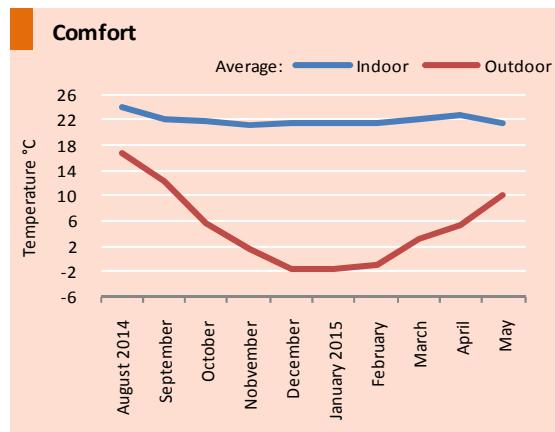


#### The energy savings and comfort

The analysis of the collected data showed energy savings for space heating of 42.4% and a 95% reduction of the circulation losses for the domestic hot water system. In total, energy saving summed up to **52.8%**, which in absolute terms equals to energy savings of 238 MWh or 62.7 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.



The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider and it is monitored and maintained between the agreed levels, which around 21.5°C.



### Before renovation



### After Renovation



## Case study 5: Viestura Street 10a

### The building

This building belongs to the 103 standard type building and it was built in 1980. It is a 4 storey building with 3 staircases. The average height of one storey is 2.5 m; the total surface area is 2978.70 m<sup>2</sup>, of which 1682.00 m<sup>2</sup> are heated in winter. There are 33 apartments in the building.

### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (10 cm mineral wool panels), of the attic (20 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the renovation of the space heating system with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated, the staircases were plastered and repainted, the balconies were also replaced with modern loggias.

### The investment

Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation	1 724 €	1 724 €	
Insulation of walls	68 618 €	68 618 €	
Insulation of cellar ceiling	7 515 €	7 515 €	
Insulation of attic	23 576 €	23 576 €	
Replacement of windows	24 956 €	24 956 €	
<b>Engineering</b>			
Heat substation		0 €	
Space heating system	30 341 €	30 341 €	
Domestic hot water system	18 013 €	18 013 €	
Cleaning ventilation shafts	1 750 €	1 750 €	
Monitoring system	1 885 €	1 885 €	
<b>Other renovation measures</b>			
Roof renovation	138 €	138 €	
Staircase	7 331 €	7 331 €	
Entrance halls	1 668 €	1 668 €	
Balcony	7 727 €	7 727 €	
<b>Other costs</b>	<b>427 €</b>	<b>5 043 €</b>	<b>5 470 €</b>
<b>Total</b>	<b>177 081 €</b>	<b>23 631 €</b>	<b>200 712 €</b>

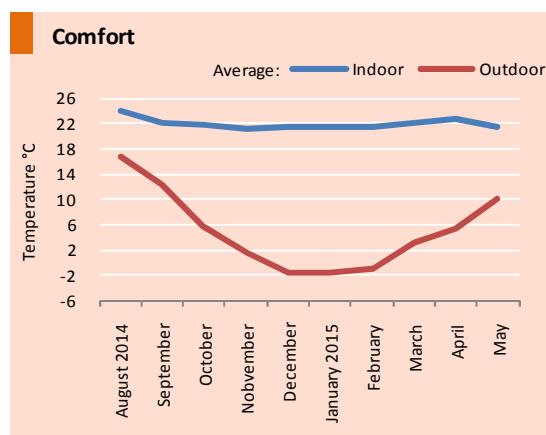
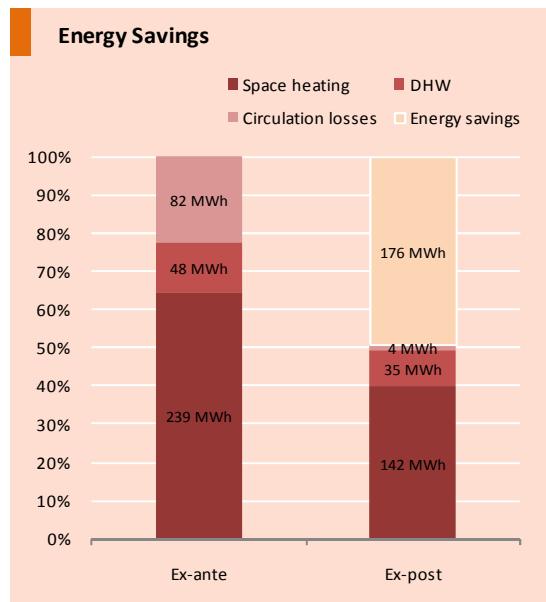


### The energy savings and comfort

After completion of the construction works, the results are closely monitored.

The analysis of the collected data showed energy savings for space heating of 40.6%, for circulation of domestic hot water of 94.8% meaning total energy savings of **54.5%**. In absolute terms this equals energy savings of 146 MWh or 46.6 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.

The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider and it is monitored and maintained between the agreed levels, which is around 21.5°C



### Before renovation



### After Renovation



## Case study 6: Vilku Street 5

### The building

This building belongs to the 103 standard type building and it was built in 1980. It is a 4 storey building with 3 staircases. The average height of one storey is 2.5 m; the total surface area is 2433.70 m<sup>2</sup>, of which 1739.80 m<sup>2</sup> are heated in winter. There are 33 apartments in the building.

### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (10 cm mineral wool panels), of the attic (20 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the integration of a heat pumps with vertical geothermal probes, the renovation of the space heating system with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated, the staircases were plastered and repainted, the balconies were also replaced with modern loggias.

### The investment

Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation	727 €	727 €	
Insulation of walls	61 773 €	61 773 €	
Insulation of cellar ceiling	7 428 €	7 428 €	
Insulation of attic	8 533 €	8 533 €	
Replacement of windows	26 389 €	26 389 €	
<b>Engineering</b>			
Space heating system	51 193 €	51 193 €	
Domestic hot water system	25 087 €	25 087 €	
Cleaning ventilation shafts	838 €	838 €	
Monitoring system	1 885 €	1 885 €	
<b>Other renovation measures</b>			
Roof renovation	208 €	208 €	
Staircase	7 363 €	7 363 €	
Entrance halls	4 063 €	4 063 €	
Balcony	9 399 €	9 399 €	
Other costs	3 415 €	3 499 €	6 914 €
<b>Total</b>	<b>186 541 €</b>	<b>25 259 €</b>	<b>211 800 €</b>

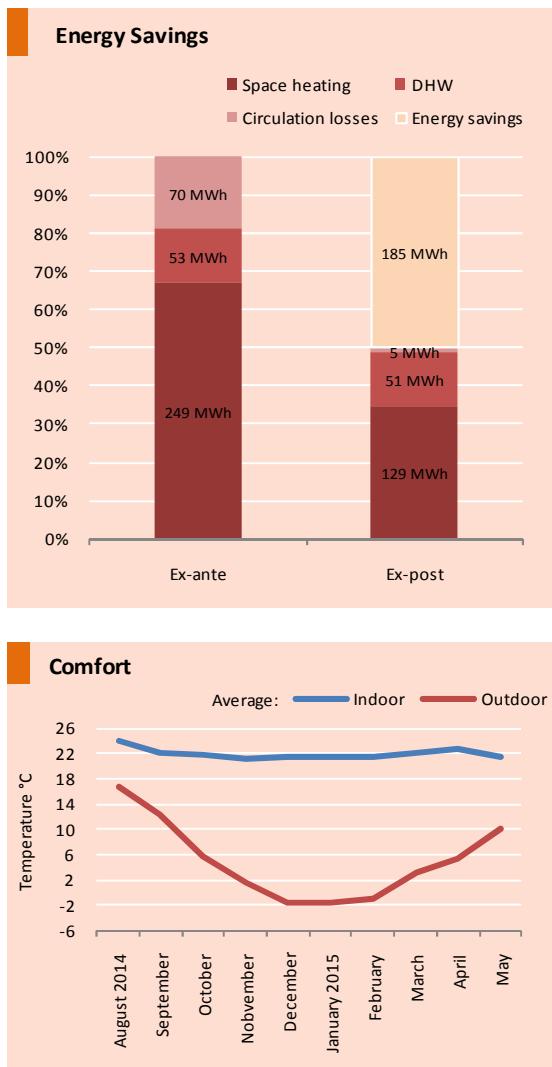


### The energy savings and comfort

After completion of the construction works, the results are closely monitored.

The analysis of the collected data showed energy savings for space heating of 48.2% and a 92.9% reduction of the circulation losses for the domestic hot water system. In total, energy saving summed up to **58.0%**, which in absolute terms equals to energy savings of 185 MWh or 48.8 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.

The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider and it is monitored and maintained between the agreed levels, which around 21.5°C.



Before renovation



After Renovation



## Case study 7: Zirnu Street 21

### The building

This building belongs to the 316 standard type building and it was built in 1968. It is a four storey building with three staircases. The average height of one storey is 2.5 m; the total surface area is 2074.70 m<sup>2</sup>, of which 1643.90 m<sup>2</sup> are heated in winter. There are 35 apartments in the building.

### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (10 cm mineral wool panels), of the attic (30 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the renovation of the space heating system with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design. The first time in Latvia as a pilot and test case, centralized the mechanical ventilation system

with heat recovery were implemented in the building.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the aesthetics of the building. For example, the roof was renovated, the staircases were plastered and repainted, the balconies were also replaced with modern loggias.

### The investment

Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Insulation of walls	63 718 €		63 718 €
Insulation of cellar ceiling	9 587 €		9 587 €
Insulation of attic	7 008 €		7 008 €
Replacement of windows	16 968 €		16 968 €
<b>Engineering</b>			
Space heating system	28 721 €		28 721 €
Domestic hot water system	15 582 €		15 582 €
Ventilation heat recovery	32 719 €		32 719 €
Cleaning ventilation system		7 016 €	7 016 €
<b>Other renovation measures</b>			
Roof renovation		5 462 €	5 462 €
Staircase		5 354 €	5 354 €
Entrance halls		986 €	986 €
Balcony		7 440 €	7 440 €
Other costs	3 984 €	2 097 €	6 081 €
<b>Total</b>	<b>178 287 €</b>	<b>28 355 €</b>	<b>206 642 €</b>



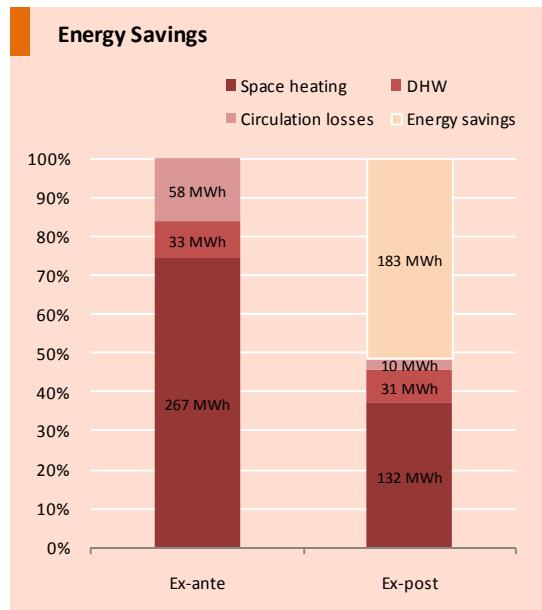
### The energy savings and comfort

After completion of the construction works, the results are closely monitored.

The analysis of the collected data showed energy savings for space heating of 50.6% and an 82.8% reduction of the circulation losses for the domestic hot water system. In total, energy saving summed up to **56.3%**, which in absolute terms equals to energy savings of 183 MWh or 48.3 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.

The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider

and it is monitored and maintained between the agreed levels, which around 21.5°C.



### Before renovation



### After Renovation



## Case study 8: Stacijas Street

28

### The building

This building belongs to the 318 standard type building and it was built in 1973. It is a four storey building with four staircases. The average height of one storey is 2.5 m; the total surface area is 2656.0 m<sup>2</sup>, of which 2098.7 m<sup>2</sup> are heated in winter. There are 42 apartments in the building.

### The project

The renovation project of this building consisted of the restoration of exterior surfaces and structural components including the installation of thermal insulation on the exterior walls (10 cm mineral wool panels), on the attic (30 cm loose mineral wool) and on the basement ceiling (10 cm extruded polystyrene). The project included the replacement of all old windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the renovation of the heat substation and the installation of a heat pump with vertical geothermal probes replacing the old coal fired boiler. The space heating system has been

retrofitted with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic. Heat control and distribution has been separated for the long north and south façade.

Additional measures were also undertaken in order to address serious technical problems and also improve the building look. For example, the roof was renovated, the staircases were re-plastered and painted and the cold water system was reconstructed.

### The investment

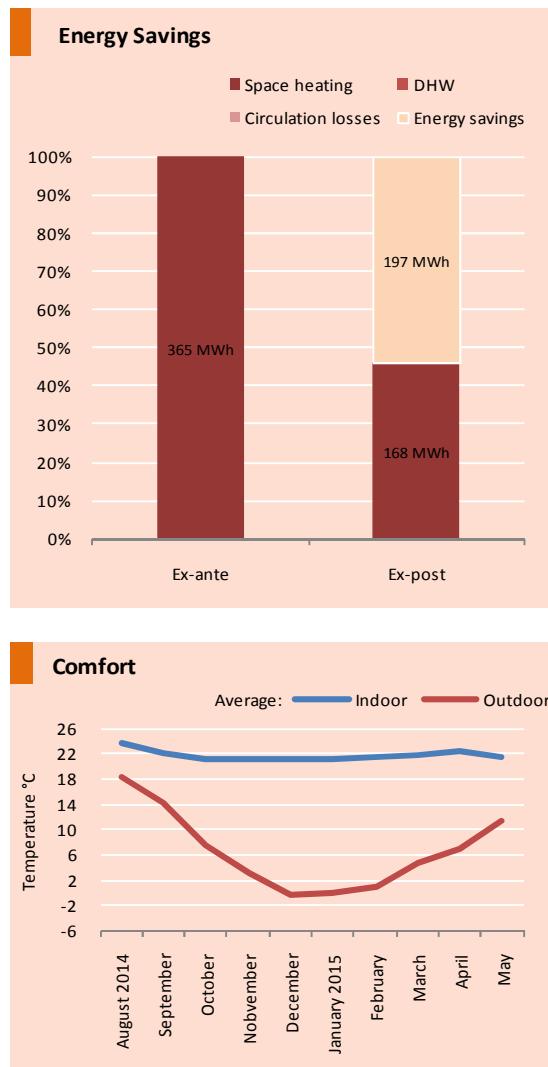
Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation		1 626 €	1 626 €
Insulation of walls	73 117 €		73 117 €
Insulation of cellar ceiling	11 524 €		11 524 €
Insulation of attic	21 909 €		21 909 €
Replacement of windows	31 276 €		31 276 €
<b>Engineering</b>			
Space heating system	67 006 €		67 006 €
Cleaning ventilation shafts		3 945 €	3 945 €
Monitoring system		3 547 €	3 547 €
<b>Other renovation measures</b>			
Roof renovation	27 989 €	27 989 €	
Staircase		7 463 €	7 463 €
Entrance halls		6 858 €	6 858 €
<b>Other costs</b>	<b>5 094 €</b>	<b>3 557 €</b>	<b>8 651 €</b>
<b>Total</b>	<b>209 926 €</b>	<b>54 985 €</b>	<b>264 911 €</b>
<b>A heat pump system</b>			<b>55 129 €</b>



### The energy savings and comfort

After completion of the construction works, the results are closely monitored. The analysis of the collected data showed **54%** energy corresponding to 197 MWh or 52 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions. This building does not have a centralized domestic hot water system.

The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider and it is monitored and maintained between the agreed levels, which around 21.0°C.



**Before renovation**



**After Renovation**



## Case study 9: Kaijas Street 6

### The building

This building belongs to the 103 standard type building and it was built in 1978. It is a 3 storey building with 5 staircases. The average height of one storey is 2.5 m; the total surface area is 3668.10 m<sup>2</sup>, of which 2437.66 m<sup>2</sup> are heated in winter. There are 42 apartments in the building.

### The project

The renovation project of this building consisted of the restoration of exterior surfaces and structural components including the installation of thermal insulation on the exterior walls (10 cm mineral wool panels), on the attic (30 cm loose mineral wool) and on the basement ceiling (10 cm extruded polystyrene). The project included the replacement of all old windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the renovation of the heat substation, the full refurbishment of the space heating system, including pipes, new radiators and thermostatic valves. The domestic hot water circulation system was fully reconstructed

using a modern and new energy efficient design.

Additional measures were also implemented in order to address serious technical problems and for improving the building look. For example, the roof was renovated, the staircases were re-plastered and painted, the loggias were renewed using ventilated facades elements.

### The investment

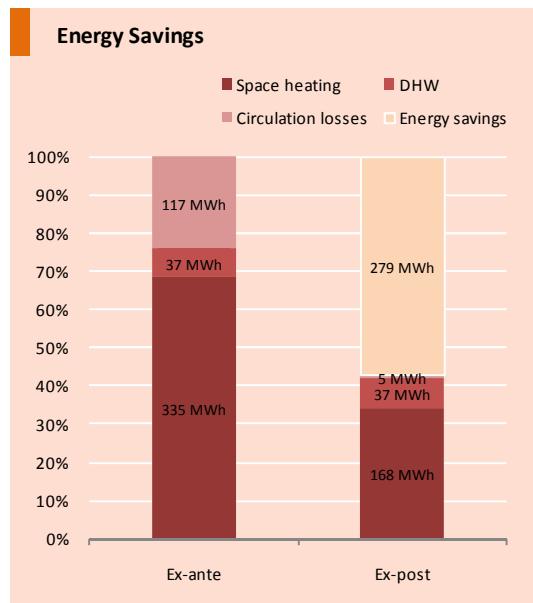
Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation		16 096 €	16 096 €
Insulation of walls	126 367 €		126 367 €
Insulation of cellar ceiling	18 517 €		18 517 €
Insulation of attic	13 705 €		13 705 €
Replacement of windows	59 011 €		59 011 €
<b>Engineering</b>			
Heat substation	3722 €		
Space heating system	37 605 €		37 605 €
Domestic hot water system	16 202 €		16 202 €
Cleaning ventilation shafts		450 €	450 €
<b>Other renovation measures</b>			
Roof renovation	25 571 €	25 571 €	
Staircase	13 578 €	13 578 €	
Entrance halls	4 495 €	4 495 €	
Balcony	16 367 €	16 367 €	
Other costs	4 126 €	4 269 €	8 395 €
<b>Total</b>	<b>279 255 €</b>	<b>80 825 €</b>	<b>360 080 €</b>



### The energy savings and comfort

After completion of the construction works, the results are closely monitored as part of an energy performance contract.

The analysis of the collected data showed energy savings for space heating of 49.8% and a 95.7% reduction of the circulation losses for the domestic hot water system. In total, energy saving summed up to **61.7%**, which in absolute terms equals to energy savings of 279 MWh or 73.7 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.



**Before renovation**



**After Renovation**



## Case study 10: Mastu Street 8/1

### The building

This building belongs to the special project type building and it was built in 1993. It is a five storey building with one central staircase. The average height of one storey is 2.5 m; the total surface area is 2276.4 m<sup>2</sup>, of which 1846.9 m<sup>2</sup> are heated in winter. There are 39 apartments in the building.

### The project

The building envelope was fully renovated: with the installation of thermal insulation on the outer walls (10 cm mineral wool panels), of the attic (20 cm loose mineral wool), thermal insulation of the basement ceiling (10 cm extruded polystyrene), new double-glazed windows and repairing and sealing of the doors. Then, other important energy efficiency measures included the full renovation of the space heating system (designed as a two-pipe heating system) with the installation of thermostatic valves and the replacement of the main distribution pipes in the basement and attic as well as use of automatic differential pressure controllers to ensure

optimal regulation of the space heating system. The domestic hot water circulation system was fully reconstructed using a modern and new energy efficient design. Additionally, a centralized mechanical ventilation system with heat recovery was also installed.

Together with the energy efficiency measures a series of additional actions were undertaken in order to address serious technical problems as well as to improve the building look. For example, the roof was renovated, the staircases were plastered and repainted, and all balconies were replaced with modern loggias.

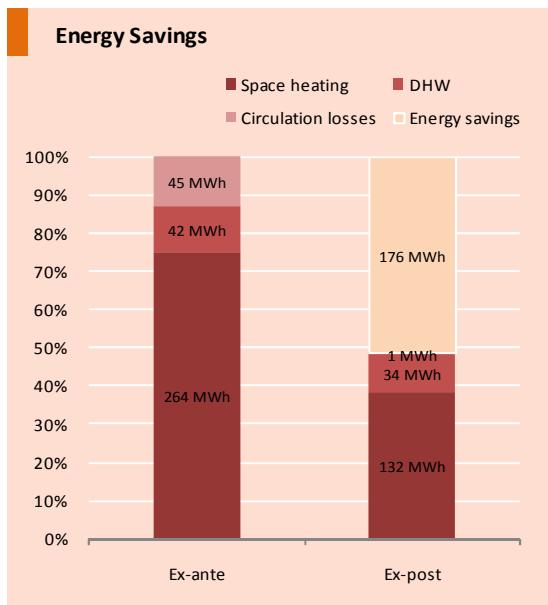


### The investment

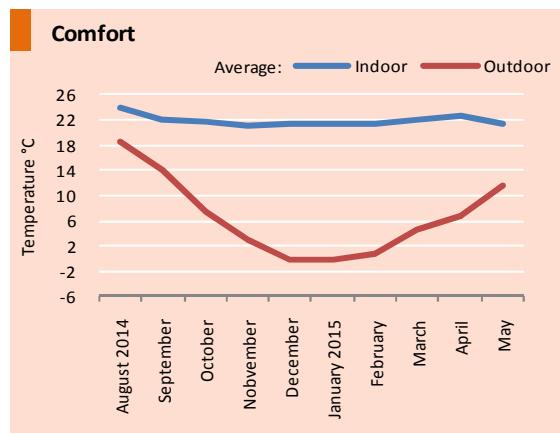
Measure	Energy efficiency	Other	Total
<b>Building fabric</b>			
Repairs of foundation	116 689€	5 533€	122 223€
Insulation of walls	13 321€		13 321€
Insulation of cellar ceiling	20 902€		20 902€
Insulation of attic	28 803€		28 803€
Replacement of windows	116 689€	5 533€	122 223€
<b>Engineering</b>			
Space heating system	22 846€		22 846€
Domestic hot water system	10 456€		10 456€
Cleaning ventilation shafts		5 198€	5 198€
Monitoring system	19 381€		19 381€
<b>Other renovation measures</b>			
Staircase		8 913€	8 913€
Other costs	4 553€	3 557€	8 110€
<b>Total</b>	<b>236 951€</b>	<b>25 300€</b>	<b>262 242€</b>

### The energy savings and comfort

After completion of the construction works, the results are closely monitored. The analysis of the collected data showed energy savings for space heating of 50.0%. Additionally circulation losses on the domestic hot water system were reduced by 97.1%. The total energy savings summed up to **56.9%**, which in energy units equals to 246 MWh or 46.4 tCO<sub>2</sub> per year. All data are normalized to standard weather conditions.



The comfort level is also an important aspect of the project. The indoor temperature is guaranteed by the Energy Service provider and it is monitored and maintained between the agreed levels, which around 21.5°C.



## Before renovation



## After Renovation

