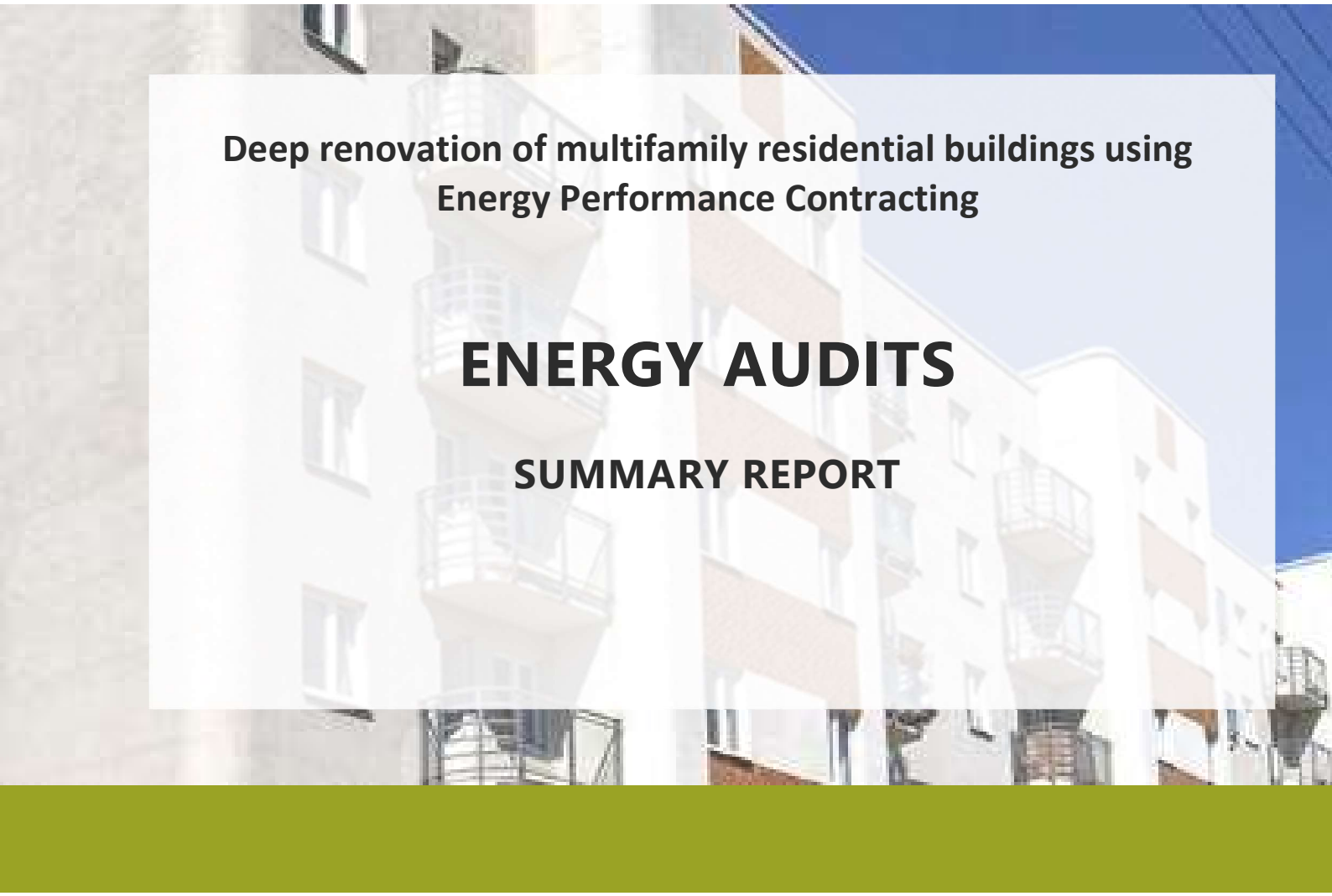
SUNShINE
SAVE YOUR BUILDING
BY SAVING ENERGY



Deep renovation of multifamily residential buildings using Energy Performance Contracting

ENERGY AUDITS

SUMMARY REPORT

Project SUNShINE: Save your bUildiNg by SavINg Energy towards 202020m^2 of deeply renovated multifamily residential buildings. - Grant 649689

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INTRODUCTION

An energy audit is a systematic procedure with the purpose of obtaining adequate knowledge of the existing energy consumption profiles of a building or group of buildings, identifying and quantifying cost-effective energy savings opportunities, and reporting the findings.

In total under the SUNShINE project 127 energy audits were carried out in different cities in Latvia (see figure 1), for supporting apartment owners of multifamily buildings to take a decision regarding the renovation and the implementation of energy efficiency improvement measures in their buildings.

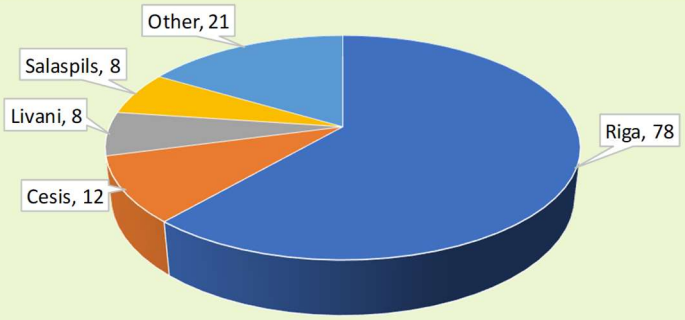


Figure 1: Distribution of buildings by town

The energy audits were carried out following an interest from the homeowners, which were reached by SUNShINE information campaigns and the ESCOs marketing activities. Also, the launching of the Latvian support programme for the renovation of multifamily buildings (management by ALTUM) provided a positive feedback and substantially increased the interest and the general demand in the market.

All buildings, which received an energy audit, were residential buildings; however, some of them also included small commercial activities, located at the first floor (like small café, hairdresser or grocery shops).

The audited buildings were standard design projects (like series 103, 104, 113, 119, 316, 318, 464, 467, 602) developed during the Soviet Union period and built from the late 60ies to the 80ies (see some example in Figure 2)

Figure 2: Example of multifamily buildings audited during the SUNShINE project

The energy audits for these buildings were implemented based on the requirement and methodologies proposed in the European Standard EN 16247:2014 (Energy audits - Part 1: General Requirements and Part 2: Buildings) and in compliances with all standards and norms in force under the Latvian regulatory framework.

The energy audits have been implemented by qualify and certified energy auditors following the requirement of the European Directive on Energy Performance in Buildings and the Energy Efficiency Directive.

Building information was collected using specific questionnaires. All buildings were inspected on site and the results discussed with apartment owners' representatives.

1. BUILDINGS GENERAL DESCRIPTION

In the period from February 2015 to February 2020, energy audits were conducted in 127 residential buildings in Latvia under the SUNShINE initiative.

In general, the building technical condition largely varied case by case, having some of the building rather well maintained and other suffering from years of deferred maintenance. However, even for well-maintained buildings, the energy efficiency potential and the needs for energy efficiency improvement measures were recognised in the auditing phase.

In some cases, building owners already took the initiative to implement few easy energy efficiency measures, such as the technical insulation of heating and domestic hot water pipes or the loft thermal insulation. Sometimes these measures were not carried out according to manufacturer specifications, or without enough care and supervision. For example, the insulation layer of pipes was already damaged, or loft thermal insulation damaged by rainwater leaky roofs (Figure 1.1).

In several buildings apartment owners year by year have already been replacing old leaky windows with new plastic profile windows. Low quality, wrong installation and poor consideration regarding indoor air exchanges, often increased indoor relative humidity rate leading to condensation problems and the risk of mould growth. This was often observed near the new windows installed by apartment owners, where surface temperatures drop due to thermal bridges (Figure 1.1).

Figure 1.1. Energy efficiency measures implemented in some of the audited buildings, without achieving the expected results

1.1. BUILDING FABRIC

The building fabric refers to the roof, ceiling, walls, windows, doors and floors of a building. It plays the leading role in the energy efficiency of a structure. Improvements to the building fabric minimize heating requirements, which lead to the downsizing of heating systems.

The ability of the fabric to transfer heat is a measured factor expressed as its heat transfer coefficients or so-called U-value[1]. Generally speaking, all inspected buildings allow large heat losses; the existing heat transfer coefficients (U-values) of the different fabric element do not anymore comply with the values proposed in modern building codes.

In the inspected buildings normal wear and lack of general maintenance are a general problem, resulting in increased damage to the building envelope and interior finishes due to rain and snow melting water infiltration.

Most of the inspected buildings have cold roofs, either pitched or flat. Roof repair is a building structural measure which should be undertaken before any energy efficiency measures (in particular in technical

[1] The 'U-Value' is a measure of the amount of energy that is transferred through an area of 1 m^2 of material when there is a 1°C difference in temperature between inside and outside. The lower the U-value the better the material is at preventing heat loss.

attics), to preserve the buildings. Another aspect to consider is air tightness, which is an important building property that severally impact energy consumption. Most of the inspected buildings showed uncontrolled inward leakage of outdoor air through cracks, interstices or other unintentional openings. Leaky buildings allow heat to escape through poorly fitted windows, doors, and wall joins, further increasing energy consumption. The old windows are typically double wooden frame in very poor technical conditions, whereas wood sashes throughout fit poorly and do not make a tight seal (Figure 1.2).

Figure 1.2. Overview of building fabric elements (left side: overview of technical attic below a pitched roof and flat roof with degradation of the parapet the concrete slab; centre: typical problems of building with red brick facades; right side: old wood frame window)

The basements of the inspected buildings are often used as storages and typically not equipped with a heating system. Often water infiltration is damaging basement and foundation walls (Figure 1.3).

Figure 1.3. Water infiltration in basement

1.2. HEATING AND VENTILATION SYSTEMS

Heating systems increase the temperature in a space compensating for heat losses between the internal space and outside. The inspected buildings are all connected to centralized heating system. In most of the cases heat energy is supplied by the city district heating system. Several buildings are already equipped with modern substations with automatic temperature compensation and building level heat metering. In few cases the buildings are equipped with outdated heat substations, lacking automatic control systems

Most of the heating networks are old and in poor technical conditions with old thermal insulation and substantial heat losses. Heating system units mainly consists of old convectors or old cast iron radiators, without thermostatic valves. The existing systems are not well balanced, causing uneven temperature distribution in the buildings. (Figure 1.4).

Figure 1.4. Left side: poorly insulated heating distribution pipes. Centre an old cast iron radiator without any thermostatic valve. Right: heat substation manually controlled

1.3. DOMESTIC HOT WATER SYSTEM

In Latvia most of the multifamily buildings are equipped with centralized domestic hot water systems. These systems are highly inefficient and outdated. The same circulation loop that supplies the hot water, is also used for towel heaters in the bathrooms. Lacking flow control systems, oversized pipes dimeters and poor technical insulation do result is large energy consumption and waste of water.

1.4. COMFORT LEVEL

Buildings are only effective when the occupants are *comfortable,* otherwise they will take alternative means of heating or cooling a space, such as auxiliary electric heaters or window-mounted air conditioners. This substantially worse energy performance. Low level of comfort also substantially affects people health.

Thermal comfort is subjective and typically difficult to quantify. It depends on the air temperature, humidity, radiant temperature, air velocity, metabolic rates, and on clothing.

Indoor air temperature is the first obvious and most important indicator, which characterize the comfort level. In residential buildings a minimum air temperature of 20°C is expected (and better if it can be set at different values in different rooms). The inspected buildings were mostly unevenly heated. Problems of overheating are not anymore detected as it was some 10-15 years ago. However, underheating of apartments most exposed to heat transfer is often an issue (first and top floor, apartment at the corner of the building).

1.5. ENERGY PERFORMANCE OF BUILDINGS

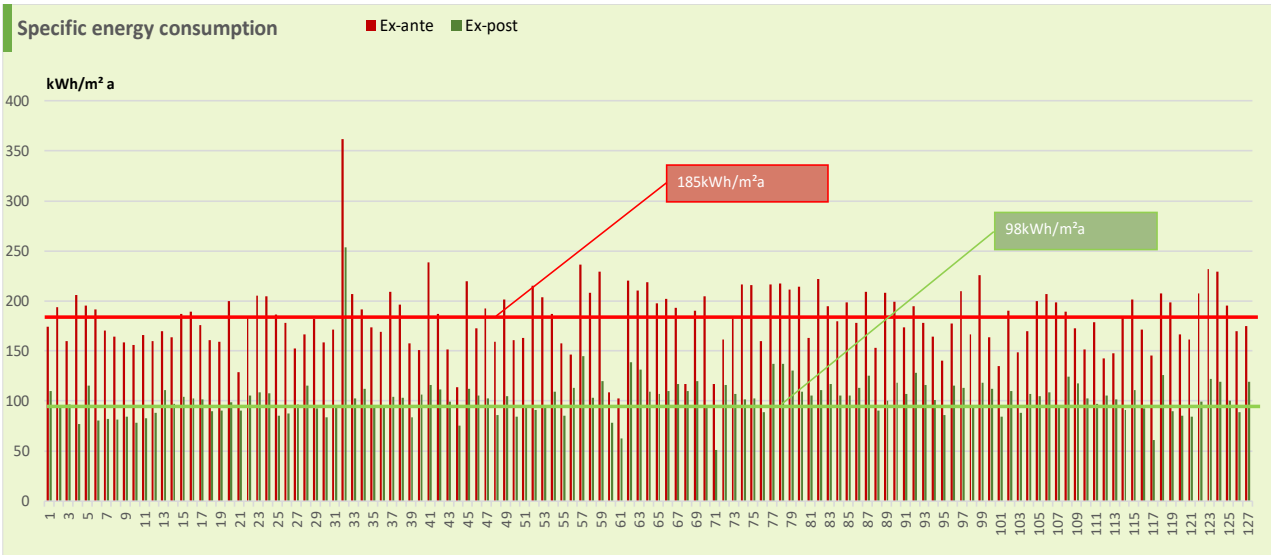
The building residential sector consumes about 40% of total heat energy in Latvia, making this sector a major contributor to greenhouse gas emissions. Energy efficiency in buildings in Latvia is on average two to three times lower than that in West European countries with similar weather conditions.

The energy performance of a building is frequently quantified by comparing its performance against that of a sample of other similar buildings (same use and type), usually through the application of a benchmark. A benchmark typically takes the form of an Energy Use Intensity (EUI) expressed for example as specific energy consumption, like kWh/m^2·a, or similar. The use of this specific units makes benchmarks easily understood and allow comparing a selected building to others.

Poor physical conditions of the buildings, low heat properties of the building fabrics, and the lack of thermostats lead to extremely high levels of heat and water consumption. This is partly offset by lowering indoor air comfort, which in some case leads to unpleasant living conditions.

Considering suitable comfort level (indoor temperatures of 20°C) the inspected buildings on average consume about **185kWh/m^2 year** (of which 137kWh/m^2 for space heating and the rest for domestic hot water preparation). Modern building can be designed with specific consumption for space heating below

50 kWh/m^2. After the implementation of the proposed energy efficiency measures the inspected building shall reach an average benchmark of **98 kWh/m² year**, of which 63kWh/m^2 for space heating (See Chart – Specific Energy Consumption).



2. BUILDING RENOVATION

Deep renovation, the idea of capturing the full economic energy efficiency potential of existing buildings with focus on building fabric and internal systems, leads to very high-energy savings. As most of the stock of University's buildings in Ukraine continues to rapidly deteriorate due to harsh weather conditions and deferred maintenance, this idea is attractive (Figure 2.1).

Figure 2.1. Building comprehensive energy efficient renovation under SUNShINE project

Realizing this potential requires designing, financing and implementing energy efficiency investments. Energy efficiency is measured understanding the annual energy needs of a building, the thermal insulation and characteristic of the building fabric and the requirements for ventilation. The heat transfer conductivity value (U-value) is a measure of thermal conductivity; the lower it is for a given construction material, the better the thermal insulation. For example, the U-value of the external walls of the mass series of buildings developed between 1960 and 1995 in Latvia is in the range of 0.9 – 1.1 W/ K m², which is more than 5 times higher than the values specified in current regulatory requirements.

Building comprehensive renovation includes the implementation of several energy efficiency measures, which have been identified and assessed during the energy auditing and project preparation process.

The next sections of this chapter provide a general description of the proposed energy efficiency improvement measures, which were proposed in the energy audits.

2.1. BUILDING FABRICS

The proposed package of measures considers a comprehensive renovation, whereas all building fabric elements are addressed, in particular:

- Replacement of existing outdated doors with new doors,
- Replacement of old windows,
- Thermal insulation of foundation walls and exterior walls,
- Thermal insulation of the basement ceilings,
- Thermal insulation of roof.

The replacement of doors and windows is recommended. The installation must ensure effective sealing between sills, jams and window frames for proper air tightness (particularly important in buildings with mechanical ventilation systems with heat recovery).

High performance glass is proposed ('low-E' glass). This has a coating applied to it to improve insulation properties, which reflect heat either back into the room or prevents it from entering the space from outside.

Figure 2.2. Installation of new energy efficient windows (Left side: installation of windows; centre: section of a triple glass plastic profile window; right side: engineering drawing for installation)

The energy audits usually propose the replacement of old windows with wooden frames with new PVC type windows. In recent years the occupants mostly have taken the replacement of the old windows upon themselves and, therefore, a variable share of windows has already been replaced. Some of these new windows are not of the best quality but replacing them is not cost-effective. However, in some cases all the windows are replaced in order to achieve higher energy savings and overall quality of the renovation, since some of the windows might be older and therefore have lower U value or have not been properly installed. All the recommended replacement windows are usually triple glazed windows with overall U-value <1.1 W/(m^2·K). Regarding entrance doors, the recommended U-value varies from 1.3 to 1.6 W/(m^2·K).

High energy losses occur through the fabric of the walls. Improving insulation here is an important measure, which help both to save energy and to protect the buildings from further deprivation. One of the most common ways to insulate a solid external wall is by applying insulation boards to the external fabric of the building using ventilated facades solutions (Figure 2.3). Another method is with External Thermal Insulation Composite System (ETICS), which in Latvia is still one of the most used ways to insulate a solid external wall. This method is executed by applying thermal insulation boards to the external fabric of the building and protecting it with a specialist render. These methods can be employed during refurbishment of existing buildings. The implementation of this rehabilitation measure requires specialized workforce and must be carefully supervised to ensure that all manufacturer' specifications are properly considered. The designer should pay attention to avoid thermal bridges and provide detailed solution drawings for all critical area (plinth, balcony, windows, parapets, entrance, etc...)

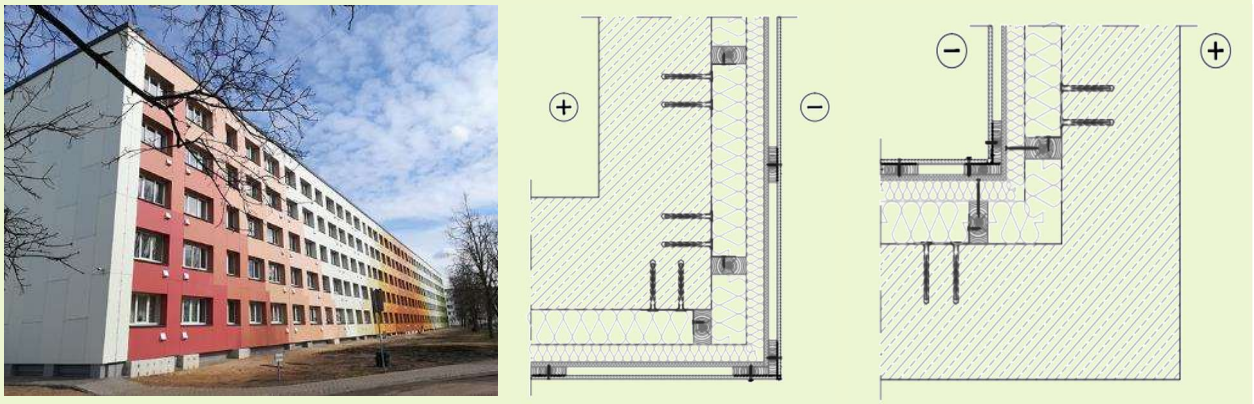


Figure 2.3. thermal insulation of exterior walls with ventilated façades (Left side: example of ventilated façades using composite material as cladding; centre and right side: example of engineering drawings for installation)

In the energy audit thermal insulation with 150 mm thick thermal insulation layer is the most recommended measure. In some cases, the thickness of the insulation layer has been increased to 180 or 200 mm in order to achieve additional energy savings, or to reach expected normative values.

While the energy savings of foundation wall insulation are less than that of above-grade wall insulation (for the same U-values), the effects is important; in particular because this efficiency measure goes side by side with moisture management of the basement and the refurbishment of the building sidewalks to avoid future damages to the implemented energy efficiency measure (Figure 2.4). After digging works, the foundation walls are cleaned and before the application of thermal insulation the application of suitable hydro insulation is required. Basement slab ceiling, for unheated basement is also carried out with the application of thermal insulation boards. Typically, this is implemented with 100-150mm thermal insulation board

Figure 2.4. Thermal insulation of foundation walls (Left side and centre: example of installation; right side: engineering drawings for installation)

Installing loft insulation in an uninsulated pitched roof or technical attics (*cold roofs*) is likely to be the most cost-effective way to improve the efficiency of the building fabric. Loose thermal insulation materials (like loose mineral wool or cellulose fibres) are typically the easiest option. (Figure 2.5).

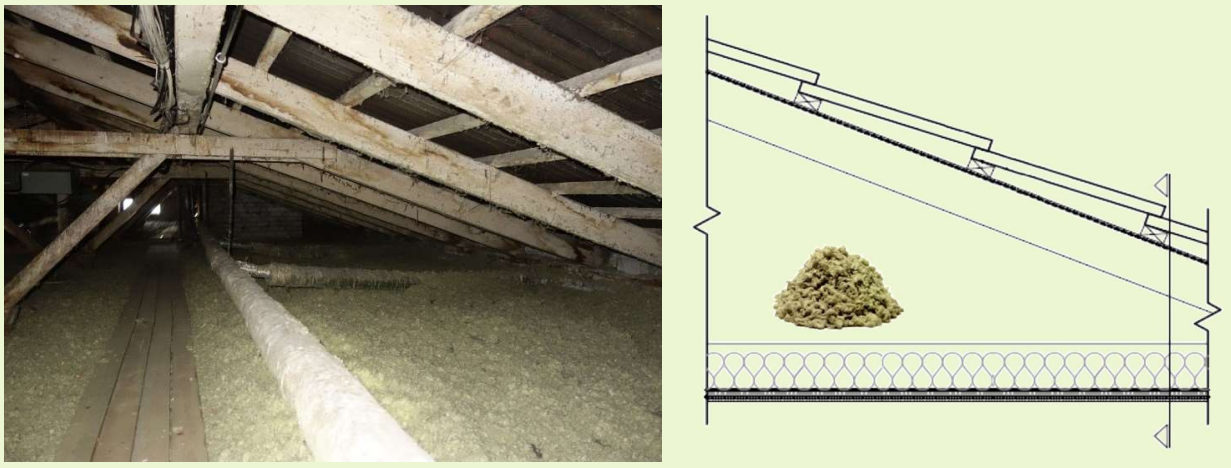


Figure 2.5. Thermal insulation on the technical attic with pitched roof (Left side: application of loose miner wool; Right side: example of engineering drawings)

Some of the audited buildings have flat roof roofs with warm deck (warm roofs), which is more expensive to insulate than flat or pitched cold roofs (Figure 2.6); however, this measure is indispensable, because in most of the inspected buildings the weatherproof membrane needs to be replaced anyway.

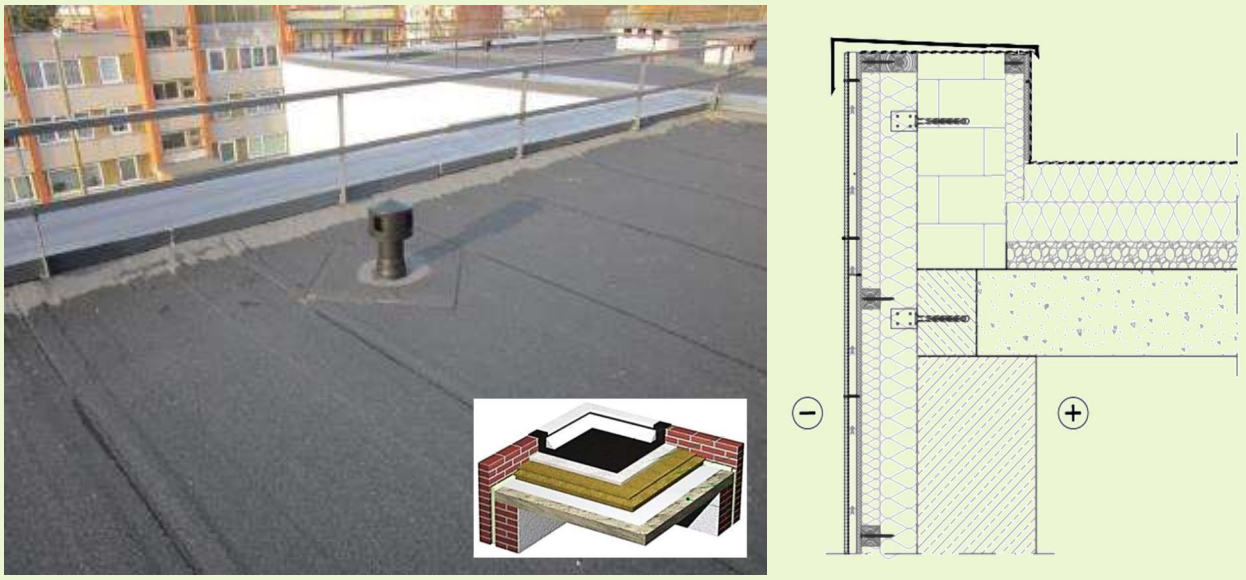


Figure 2.6. Thermal insulation on the flat roof with warm deck (Left side: example of renovated roof; Right side: example of engineering drawings for installation with details on the parapet wall)

Usually in the energy audit the recommended thickness of the insulation layer is 300 mm, however, in some cases the thickness of this layer may be reduced due to physical restrictions of the building to 200 mm or whichever is best suited for the specific case.

2.2. HEATING AND DOMESTIC HOT WATER SYSTEMS

The most cost-effective solution is the application of technical insulation to existing distribution pipes of these systems in the unheated parts of the building such as technical attic or basement. Other cost-effective measures for the heating system include hydraulic balancing for even temperature distribution throughout the building and installation of thermostatic valves in each of the apartments.

However, in most of the cases a complete reconstruction of the heating system is necessary as the existing systems are fully depreciated, outdated and in critical conditions. Additionally, apartment owners have often modified the systems, installing new and different radiators and valves, further contributing to uneven distribution of the thermal energy in the building.

Therefore, in order to reach the expected energy savings, alongside with improving the thermal characteristics of the building fabric, additional measures are recommended for the heating system. In particular:

- The reconstruction of the space heating systems,
- The installation of new heat substations.

Most of the existing buildings have one pipe systems without specific balancing solutions. However, independently from the system configuration, when renovating a heating system all main distribution pipes in the basement and technical attic must be insulated using ad-hoc technical insulation solutions. Then the system must include the installation of thermostatic radiators valves and suitable balancing valves for even temperature distribution throughout the building (Figure 2.7).

Figure 2.7. Left side: installation of thermostatic valves for local temperature regulation; centre: installation of balancing valve for even temperature distribution in the building; right side: technical insulation of heating pipes

Most of the existing multifamily buildings in Latvia are equipped with a centralised domestic hot water system. The circulation loop of these systems is also used for space heating of the bathroom (towel heaters). The systems are often in rather poor technical conditions with substantial heat losses.

In a comprehensive building renovation project this system is renovated; In the phase of energy audits these solutions are analysed:

- The existing system is decommissioned. Bathroom towel heaters are connected to the space heating system and a new domestic hot water system is installed. The new system is planned minimising pipe diameters and length of the circulation loop. This aims at minimizing building energy consumption.
- The existing system is retrofit, replacing all distribution pipes, but using the same system configuration.

Regarding the hot water system, it is important to take into the consideration the indoor pipes of circulation circuit and consider insulating them as well. It is also important to mention that usually the preparation of hot water takes place in the central heating unit of the building, however, there are also buildings, where hot water is prepared individually in each apartment. In these cases, the most common device for hot water preparation is an electric boiler.

3. ANALYSIS OF THE PORTFOLIO OF BUILDINGS

An important part of the development of any project is the evaluation of its costs and benefits. The current portfolio covers 127 multifamily buildings encompassing about 313,000 m² of heated area.

At the stage of energy auditing the possibilities of project financing were not considered. Thus, the side effect of project financing such as interest of loans obtained, taxes (like VAT) have not been considered in the energy audits.

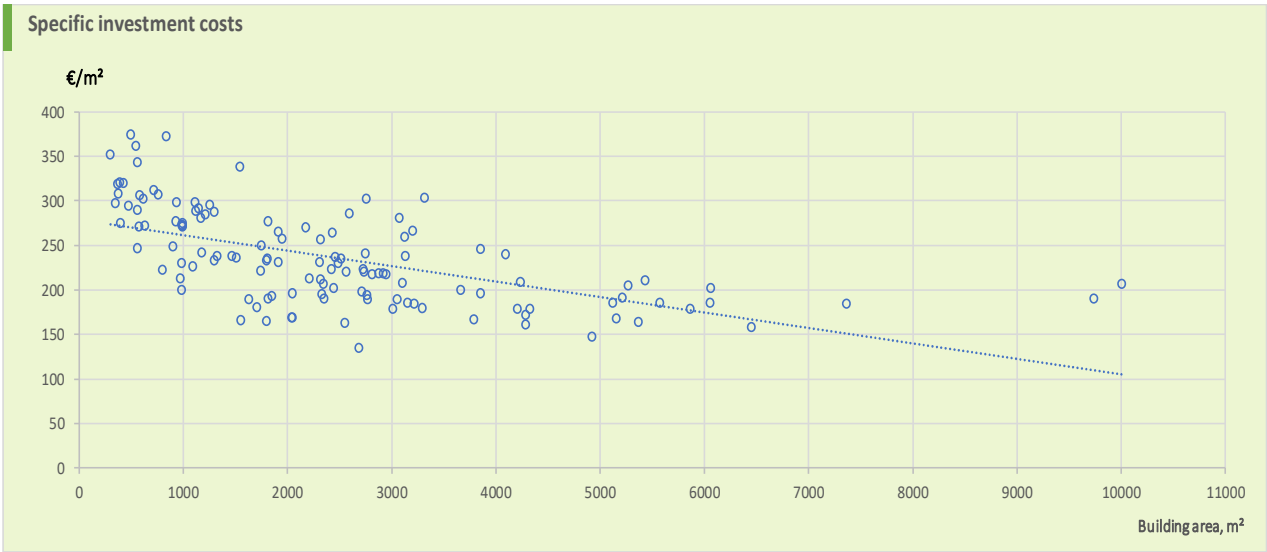
The proposed analysis, which is based on the results of the energy audits, gives a basic introduction to standard project profitability calculations

3.1. INVESTMENT COSTS

The investment costs component includes all expenses connected with project implementation. This normally includes design & planning, project management, construction cost (purchase of material, components, equipment, installation, control and testing, commissioning, training, etc.) and taxes.

In the energy audit the investment costs for the implementation of energy efficiency measures have been identified for each building. These costs have been calculated based on market trends and analysis considering current equipment, material and labour costs in Latvia. These investment costs specifically cover the construction phase for the implementation of energy efficiency improvement measures.

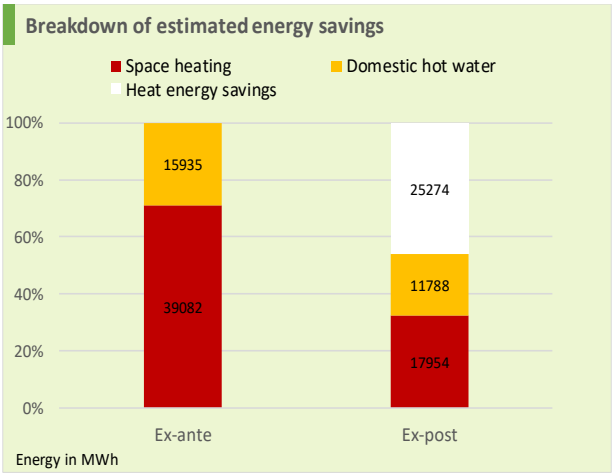
Currently the investment costs for the renovation of this portfolio of buildings are estimated at **€67.3m**, of which about 64% are for improving building fabrics, 32% for the reconstruction of the heating and domestic hot water systems and 4% other measures linked to the proposed energy efficiency measures. The average investment benchmark for these buildings is about **236 €/m²**. Variation from this benchmark are mostly linked to the size and type of building, whereas larger building shows lower specific cost and 103 series buildings are typically more expensive to renovate compared to other serial building projects.



The comprehensive renovation of buildings is a highly effective structural investment. Keeping the current assets in good conditions, investing in energy efficiency measures, is far less capital intensive compared to new constructions, which for example in Latvia are even 3-4 times more expensive (750€/m²).

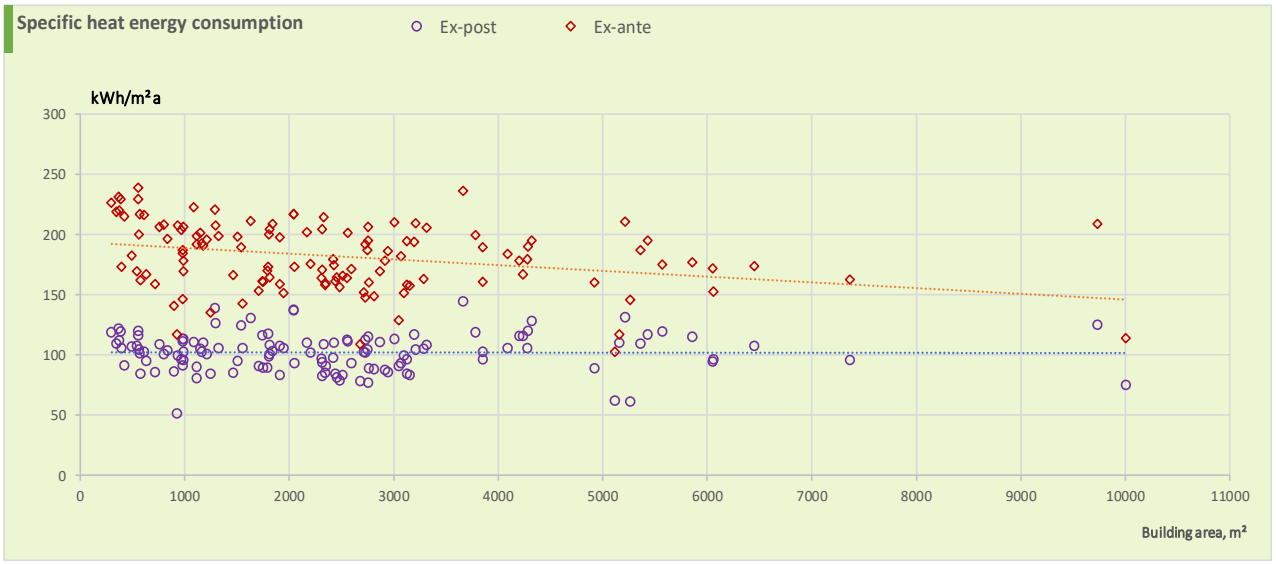
3.2. ANNUAL NET SAVINGS

The estimated energy saved per year has been calculated for each audited building and corresponds to **25.3 GWh/a** (see Chart – Breakdown of estimated energy savings) for the 127 buildings.



As expected, most of the energy and related savings are linked to space heating. On average, about three quarter of the energy is consumed for space heating and one quarter for domestic hot water preparation. The thermal energy consumption for the domestic hot water preparation and related circulation losses is calculated according to methodologies proposed by the energy auditors. These methodologies are based on the metered volumetric hot water consumption (m^3) and on an estimation of the heat circulation losses.

The specific energy consumption before renovation for the audited buildings varies between 150 to 250 kWh/m^2 year (including domestic hot water). After building renovation this consumption drops to 70 to 135 kWh/m^2 year (including domestic hot water).



ANNEX I – LIST OF BUILDINGS AND MAIN DATA

All energy audit reports are available in Latvian language upon request

Nr.	City	Area	Ex-ante					Ex-post				
			Space heating	DHW	Total	Total	Heating Specific	Space heating	DHW	Total	Total specific	Heating Specific
		m²	MWh	MWh	MWh	kWh/m²	kWh/m²	MWh	MWh	MWh	kWh/m²	kWh/m²
1	Cēsis	2433	290	134	424	174	119	155	114	269	110	64
2	Cēsis	3127	431	176	608	194	138	179	122	301	96	57
3	Cēsis	3853	408	209	618	160	106	194	177	371	96	50
4	Dobele	2758	367	202	569	206	133	149	63	213	77	54
5	Olaine	2760	354	185	539	195	128	148	170	318	115	54
6	Dobele	1120	140	75	215	192	125	62	28	90	81	56
7	Līvāni	2316	340	56	396	171	147	135	56	191	83	58
8	Līvāni	2458	348	57	405	165	142	144	57	201	82	59
9	Līvāni	3132	422	73	496	158	135	192	73	265	85	61
10	Līvāni	2486	333	57	389	157	134	139	57	195	79	56
11	Līvāni	2517	360	58	418	166	143	152	58	209	83	60
12	Rīga	4924	489	299	787	160	99	206	230	436	89	42
13	Rīga	2873	293	195	488	170	102	146	173	318	111	51
14	Rīga	2312	271	108	379	164	117	117	108	225	97	51
15	Rīga	2750	353	161	514	187	128	145	142	287	104	53
16	Rīga	3854	501	229	730	189	130	218	177	395	103	57
17	Rīga	2208	249	138	388	176	113	106	119	225	102	48
18	Rīga	1751	186	96	282	161	106	79	78	157	90	45
19	Rīga	2353	302	73	375	159	128	141	73	214	91	60
20	Rīga	1810	261	101	361	200	144	105	73	178	99	58
21	Rīga	3051	252	141	394	129	83	136	141	277	91	44
22	Rīga	4092	455	296	751	184	111	203	231	434	106	50
23	Rīga	3315	408	272	681	205	123	161	198	360	108	49
24	Rīga	1817	277	94	372	205	153	107	89	196	108	59
25	Rīga	2946	346	203	549	186	118	153	99	252	86	52
26	Rīga	2921	337	183	520	178	115	151	105	256	88	52
27	Rīga	6059	596	327	924	152	98	269	315	585	96	44
28	Salaspils	4239	425	282	706	167	100	234	255	490	116	55
29	Salaspils	3073	385	173	559	182	125	163	122	286	93	53
30	Salaspils	1912	249	54	303	159	130	102	58	160	84	53
31	Salaspils	6058	641	399	1040	172	106	175	399	574	95	29
32	Salaspils	475	76	96	172	362	160	25	96	121	254	53
33	Salaspils	990	166	38	204	206	168	71	31	102	103	72
34	Salaspils	2734	360	165	524	192	132	155	154	308	113	57
35	Līvāni	2051	291	65	356	173	142	127	65	192	93	62
36	Līvāni	990	142	26	168	169	143	69	26	95	96	70
37	Dobele	3215	445	228	673	209	138	182	153	335	104	57

38	**Gulbene**	839	144	21	165	196	171	66	21	87	104	79
39	**Līvāni**	3154	425	72	497	158	135	191	72	263	83	61
40	**Rīga**	1947	227	68	294	151	116	139	68	206	106	71
41	**Rīga**	558	116	17	133	239	208	48	17	65	116	85
42	**Rīga**	987	167	17	185	187	170	93	17	110	111	94
43	**Rīga**	3102	408	62	470	152	132	247	62	308	99	79
44	**Rīga**	10008	924	214	1137	114	92	539	214	752	75	54
45	**Rīga**	378	71	12	83	220	187	30	12	42	112	80
46	**Rīga**	401	54	16	69	173	134	29	14	42	105	71
47	**Rīga**	1168	184	42	225	193	157	79	42	120	103	67
48	**Rīga**	717	91	23	114	159	126	38	23	62	86	54
49	**Rīga**	1151	184	48	232	201	160	73	48	121	105	64
50	**Rīga**	2442	350	43	393	161	143	162	43	206	84	67
51	**Rīga**	7365	969	231	1199	163	132	472	231	703	95	64
52	**Rīga**	427	82	10	92	215	193	29	10	39	91	69
53	**Rīga**	973	173	26	198	204	178	69	25	94	96	71
54	**Rīga**	5367	691	312	1004	187	129	304	283	588	109	57
55	**Rīga**	2347	314	56	371	158	134	165	34	200	85	71
56	**Rīga**	986	115	30	144	146	116	82	30	111	113	83
57	**Rīga**	3663	570	295	865	236	156	239	291	529	145	65
58	**Rīga**	1847	307	78	385	208	166	116	74	191	103	63
59	**Rīga**	560	102	27	128	230	182	42	25	67	120	75
60	**Rīga**	2681	242	49	292	109	90	167	43	210	78	62
61	**Rīga**	5122	454	72	526	103	89	247	72	319	62	48
62	**Rīga**	1295	214	71	286	220	165	109	71	180	139	84
63	**Rīga**	5215	700	398	1098	211	134	287	397	685	131	55
64	**Rīga**	351	63	13	77	219	181	28	11	38	110	79
65	**Rīga**	1916	251	128	379	198	131	98	108	206	107	51
66	**Rīga**	2172	303	136	439	202	140	129	110	239	110	59
67	**Rīga**	3199	370	249	619	194	116	162	212	374	117	51
68	**Rīga**	5158	319	284	602	117	62	303	264	567	110	59
69	**Rīga**	4288	538	278	816	190	125	251	263	514	120	59
70	**Rīga**	2315	398	76	474	205	172	154	62	217	94	67
71	**Salaspils**	926	97	11	108	117	105	37	11	48	52	40
72	**Rīga**	1745	209	72	282	161	120	131	72	203	116	75
73	**Rīga**	498	71	20	91	183	142	33	20	53	107	67
74	**Rīga**	575	108	17	125	217	188	44	14	58	102	77
75	**Rīga**	618	118	16	134	216	191	50	13	63	102	81
76	**Rīga**	2768	344	98	443	160	124	155	91	247	89	56
77	**Rīga**	2043	290	153	443	217	142	127	153	280	137	62
78	**Rīga**	2044	291	153	444	217	142	128	153	281	138	63
79	**Rīga**	1631	217	128	345	211	133	93	120	213	131	57
80	**Rīga**	2334	377	124	501	215	161	140	114	255	109	60
81	**Rīga**	3292	344	193	537	163	105	163	184	347	105	49
82	**Rīga**	1092	210	32	243	222	193	89	32	121	111	81

83	**Rīga**	5431	719	338	1058	195	132	323	313	635	117	59
84	**Rīga**	4284	536	232	768	179	125	238	216	454	106	55
85	**Rīga**	1329	207	57	264	199	156	91	50	141	106	68
86	**Rīga**	992	141	36	177	178	142	76	36	112	113	77
87	**Rīga**	9738	1343	690	2033	209	138	580	638	1218	125	60
88	**Rīga**	1709	221	41	261	153	129	114	41	155	91	67
89	**Rīga**	802	147	20	167	208	184	61	20	81	100	76
90	**Rīga**	3789	486	269	755	199	128	195	255	449	119	51
91	**Rīga**	6450	731	388	1119	173	113	318	374	692	107	49
92	**Rīga**	4324	503	340	842	195	116	240	314	555	128	56
93	**Rīga**	4207	422	326	748	178	100	199	288	487	116	47
94	**Rīga**	1817	261	38	299	165	143	145	38	183	101	80
95	**Rīga**	899	106	20	126	140	118	59	18	77	86	66
96	**Rīga**	5862	582	456	1038	177	99	255	421	676	115	44
97	**Rīga**	3011	450	183	633	210	149	157	183	340	113	52
98	**Rīga**	635	89	17	106	167	140	45	15	60	95	71
99	**Rīga**	301	58	10	68	226	194	26	10	36	119	87
100	**Rīga**	2554	248	171	419	164	97	133	154	287	112	52
101	**Rīga**	1251	147	21	169	135	118	77	29	106	84	61
102	**Līvi**	1177	192	32	224	190	163	97	32	129	110	82
103	**Priekuļi**	2814	354	64	418	149	126	185	64	249	89	66
104	**Cēsis**	546	78	14	93	170	143	44	14	59	107	81
105	**Cēsis**	563	91	22	113	200	162	37	22	59	105	66
106	**Priekuļi**	759	146	11	157	206	192	72	11	83	109	95
107	**Augšīgatne**	1507	270	29	299	198	179	114	29	143	95	76
108	**Cēsis**	1545	176	117	293	190	114	83	110	192	125	53
109	**Cēsis**	1801	187	125	312	173	104	87	125	211	117	48
110	**Cēsis**	2713	270	142	411	152	99	137	142	279	103	51
111	**Rīga**	2424	319	116	435	179	131	153	83	236	97	63
112	**Līvi**	1555	149	72	221	142	96	107	57	165	106	69
113	**Cēsis**	2730	248	156	403	148	91	145	134	278	102	53
114	**Cēsis**	984	156	25	181	184	159	65	24	90	91	66
115	**Cēsis**	2565	336	180	516	201	131	171	114	285	111	67
116	**Cēsis**	2595	323	122	445	171	124	135	106	241	93	52
117	**Kadaga**	5267	637	131	768	146	121	299	24	323	61	57
118	**Jaunjelgava**	1297	166	103	269	207	128	99	65	164	126	76
119	**Zilākalna**	1116	196	26	222	199	176	76	24	100	90	68
120	**Daugavpils**	1467	215	29	244	166	147	96	29	125	85	65
121	**Kalkūne**	582	82	12	94	162	141	37	12	49	84	63
122	**Silene**	936	168	26	194	207	180	67	26	93	99	72
123	**Silene**	368	74	12	85	231	200	33	12	45	122	91
124	**Silene**	388	77	12	89	230	200	35	12	46	120	90
125	**Stāķi**	1213	209	29	238	196	172	93	29	122	101	77
126	**Iecava**	1798	262	43	306	170	146	117	43	161	89	65
127	**Ķekava**	5573	558	418	976	175	100	265	400	665	119	48