

Energy saving in refurbished buildings in Latvia

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SUMMARY

The household in Latvia is the most energy capacious sector up to 40 % of the final total energy consumption has been consumed by household in 2008. According to that the energy demand in household as well as energy conservation potential are very important parts of the management and development of energy sector. The paper presents the latest development in Building sector and in Energy Efficiency in Building sector involved Legislative aspects, Framework changes, which influence building refurbishment process in Latvia.

INTRODUCTION

Housing stock of Latvia at the end of the year 2008 was 61 mln.m². Up to 65% of total housing stock is in urban area and 35% - in rural area. To a large extent residential buildings in the Latvia are old (erected before than 1990). Due to the age of the buildings and mild standards for building heat protection that were in force in the past, heat consumption in most of the buildings is high.

According to the Latvian Energy Efficiency Strategy for the years 2008 - 2010 following goals should be achieved until 2016:

- Energy audit realization in multi - family houses;
- Energy audit realization in public and municipal buildings;
- Reducing average energy demand index in buildings from 220 – 250 kWh/m²/year to 195 kWh/m²/year in 2016 and to 150 kWh/m²/year in 2020;
- Reducing average energy demand index in buildings from 220 – 250 kWh/m²/year to 150 kWh/m²/year in 2020.

Only some energy efficiency actions in building sector were realized till year 2007. The refurbishment operation proceeded in the same time that the main changes in Energy Efficiency in Building sector involves Legislative changes - Law on the Energy Performance of Buildings, Framework changes - State Agency of Constructing, Energy and Housing, which influence building refurbishment process in Latvia.

The Law on the Energy Performance of Buildings came into force in 2 April 2008 in Latvia in accordance with the EU Directive 2002/91/EK. Fully eligible this Law became from the 1 of January 2009.

The objective of this Law is to promote a rational utilisation of the energy resources and to improve the energy performance of buildings.

The Law shall determine the competence of the State and local government institutions in the field of energy performance of buildings, as well as the legal and organisational grounds for the energy certification of buildings.

METHODS

Refurbishment projects focused on the large stock of apartment buildings built before 1990. The process of Building refurbishment for Energy Efficiency actively started only in the last 5 years in Latvia and unfortunately this process going rather slowly especially in comparison with the other EU states.

The standardized buildings comprise 65% of the building stock. District heating is widespread in Latvia. Latvia has one of Europe's highest coverage of district heating. The remaining heating demand is covered by mainly natural gas and biomass (in rural areas). For the district heating there has been a substantial fuel shift from heavy fuel oil towards natural gas and biomass (Latvia has significant resources of the latter). In many cases the heating systems in multi family houses cannot be regulated.

For the multi family houses 76% of the buildings are erected from 1958 to 1992. Especially for this category there is a large saving potential because many of the buildings are standard buildings and standard measures can be applied.

The total housing stock comprises 57 million m². The most common 13 standard multifamily houses comprises 37 million m² or 65% of the housing stock.

Refurbishment projects of Latvia has concentrated the analyses of the energy saving potential to the residential sector of which the major part is dominated by standard buildings representing a potential which are in reach with standardised measures.

For the whole building sector estimated saving potential of 30-50% resulting in 15 PJ. For the public buildings estimated saving potential 20-60% resulting in 2.052 PJ.

Table 1. Standard multi family houses in Latvia

Series/stores/ year	m ² (% of total housing stock)	energy consumption kWh/m ²	Construction principle
1-316/4-5 1957-1964	5655000 (10%)	187-211	Base longitudinally walls of silicate brick, ceiling panels: armoured concrete panels. Gable roof
1-318/ 5 from 1964	1889000 (3%)	187-211	Same but flat roof
1-464/ 5 From 1959	996000 (2%)	187-211	Schema: spatial construction. Walls of ceramic concrete, ceiling panels of armoured concrete panels by circuit, gable roof
464A / 5 From 1961	976000 (2%)	187-211	Schema: same
464A-π /5 From 1964	976000 (2%)	187-211	Schema: same
464A- π6/ 5 From 1966	976000 (2%)	187-211	Schema: same but flat roof
467A / 5 From 1967	3848000 (7%)	124-224	Scheme: base cross walls, wall material: aero- concrete, ceiling panels: concrete panels, flat roof
467 / 9 From 1976	3848000 (7%)	124-224	Scheme: same
467B/9 From 1976	3848000 (7%)	124-224	Scheme: same
602/9 From 1967	3715000 (6%)	155-212	Schema: spatial construction. Walls of ceramic concrete, ceiling panels of armoured concrete panels by circuit, flat roof
104/5-6 From 1969	2654000 (5%)	134-218	Schema: base cross walls, ceramic concrete walls, ceiling panels: concrete panels, flat roof

103	5-6	7298000 (13%)	124-224	Schema: same
From 1969				
119	6-9	407000 (0.7%)	171-194	Schema: carcass construction, wall material: three-group panels, ceiling panels: concrete panels, flat roof
From 1980				

In 2004/2005 91 of the standard buildings were tested for energy consumption with the following results: (column 4-6 are indicative calculations).

Table 2. Energy saving potential apartment buildings

1 Series	2 Total stock in m ²	3 Average heat consumption kWh/m ² /year	4 Indicative heat consumption per year	5 Indicative saving potential compared to national strategy (150 kWh/m ²)	6 Indicative saving potential in%
103	7298000	174,22	1271 GWh	176 GWh	14%
104	2654000	198,85	528 GWh	129 GWh	24%
467	11544000	176,06	2032 GWh	301 GWh	15%
602	3715000	181,00	672 GWh	115 GWh	17%
Total	25211000	178,65	4503 GWh	722 GWh	16%

Another survey in 2004/2005 based on a questionable low number of test revealed average consumptions in 2-6 floor buildings erected after 1945 to be 199.38 kWh/m². If the above mentioned 13 standard buildings with 37 million m² is compared with the strategy to reduce consumption to 150 kWh/m² a saving potential of 1846 GWh/a – or 1.8 TWh/a - can be indicated.

Please note that the above indicative potentials are speculative and based on a limited amount of statistics. However it is clear that a very large saving potential for building retrofitting is present in the standard buildings.

Refurbishment projects Latvia suggests a rehabilitation strategy in 3 groups with first groups of more simple and inexpensive measures and the last group for major rehabilitations.

Group 1, measures: cold and hot water receiving devices adjustment; water consumption meters installations in apartments; apartments windows and doors of loggias renovation/packing; street door renovation; loggias glazing; reconstruction or change of existing heat substations, providing automatic heat supply in accordance with regulation from outdoor temperatures; risers pipelines balancing.

Comments: These measures are required for the main part of the buildings. It is possible to obtain 20-30% savings and payback time can be 4-5 years. Buildings with insufficient savings will have smaller benefit and longer pay back time. Heating and hot water supply systems and distribution systems must be made. Measures can be realised when it is financially feasible. Often heat energy providers carry out heat substations reconstruction in stages.

Investments:

- Water consumption meters installations in apartments: 30 €/devices;
- Apartments windows and doors of loggias renovation/packing: 43 €/m², 57 €/m²;
- Loggias glazing: 16 €/m²;
- Reconstruction or change of existing heat substations, providing automatic heat supply in accordance with regulation from outdoor temperatures: 10 €/m².

Group 2, measures: insulation of external walls; insulations of the balks covering; automatically regulated ventilation systems installation in the bathrooms and kitchens; heating system reconstruction from one pipe system to two pipe systems (might be considered).

Comments: These measures can be realised if group 1 is made. Additionally savings is approximately 15% of heat energy economy. Construction time of pumped ventilation systems depends from humidity problems after windows renovation/packing – it should be done one year after problem determination. Heating systems reconstruction depends on actual situation, it is not obligatory. It is relevant after group 1 and the first group 2 measures are applied.

Investments:

- Insulation of external walls: 47 €/m²;
- Insulations of the balks covering: 6 – 28 €/m².

Group 3, measures: windows and street doors replacement; thermo controller valves and individual heat energy meters installation in the apartments; insulation of the cellars coverings; insulation of the side walls; insulation of the matching part of the gable roof for 316 and 318 series and others 5 stores buildings and higher buildings.

Comments: These measures should be realised only after group 1 and 2 measures, and requires large investments. Maximum energy efficiency is a result of the above measures. Total savings from all measures are estimated to 50-60%. Long term investment planning is necessary for group 3 and pay back time is long or middle.

Investments:

- Windows and street doors replacement: 25 €/m², 71 €/m²;
- Thermo controller valves and individual heat energy meters installation in the apartments: 10 €/m²;
- Insulation of the cellars coverings: 7 €/m²;
- Insulation of the side walls: 44 - 57 €/m²;
- Insulation of the matching part of the gable roof for 316 and 318 series and others 5 stores buildings and higher buildings: 36 €/m².

Refurbishment projects Latvia mentions other relevant rational use of energy resources (RUE) measures: modernisation of heat sources by replacement of heavy fuel oil or coal boilers by gas/biomass boilers, replacement with energy saving lamps or fixtures, installation of solar thermal systems, geothermal systems.

Measures: windows changing, wall insulation, top floor ceiling insulation, installation of new radiators with thermo regulation, installation of heat meter on each radiator, insulation of basement ceilings. These measures which are rather similar to the above group 3 have resulted in savings from 46% 55%. For a 5 floors residential building the investments ranges from 120000 € to 390000 €.

The real situation in building sector and in related branches was revised in papers. Financing schemes that were used before for building refurbishment projects in Latvia were revised also and analysis of existing schemes for building refurbment projects was prepared. Proposals of the possible financial mechanisms and for improvement of projects financing were prepared. Participation in the development of implementation mechanisms for Green investments schemes.

Good cooperation with the Ministry of Environment and the main institutions involved in the practical implementation details development process has been established. It is a very good place for supporting development of the most efficient mechanism for increasing of energy efficiency in building sector. The main result is the Green investments use for public and municipal buildings.

Energy saving potential

With 13 standard types of residential buildings there is an obvious potential for standardised saving solutions. Some of the building types are rather, so in reality there are 8 different standard types. Group 1 and 2 measures could contribute significantly to the savings, where as Group 3 measures require a longer pay back time. Since a lot of these standard buildings are coming at age, it should be considered to introduce Group 3 measures, when major refurbishments are necessary. With the high degree of standardisation there is a lot to be gained with standardised solutions. Planning and audits can be carried out after common methodology and the retrofitting programmes should also benefit from economy to scale. With regards to the organisation and decision-making of the tenants there will also be similarities which will also call for organisational standard measures – and also with regard to financial solutions.

With implementation of Group 1 and 2 measures an energy saving effect on 35-45%. This is probably an optimistic estimate, but alone savings on 25% seems to fulfil the governments plan to reduce energy consumption to 150 kWh/m². As estimated from table 4.2 an energy saving potential of 1846 GWh seems to be within reach.

RESULTS

Refurbished approaches

Latvia: step-by-step refurbishment and complex refurbishment

Both approaches were analyzed from point of view of:

- technical measures taken;
- energy saving effects achieved – based on monitoring results;
- barriers for project implementation.

Some refurbishment projects have been implemented within the framework agreement between the Federal Ministry for the Environment, Nature Protection and Nuclear Safety of Germany and the Ministry of Environment of the Republic of Latvia. The projects are located in 4 regions of Latvia – Riga, Saldus (Broceni), Liepaja and Limbazi (Salacgriva). The project owner in Riga and Salacgriva projects case are associations of apartment owners, but in case of Broceni and Liepaja – municipalities.

The projects owners in realised projects were:

- Associations of apartment owners – in this case association took a loan and accordingly they went through all the formalities including all administrative, technical and financial actions (projects –Riga, Cesis, Sigulda).
- Municipalities (Broceni, Liepaja, Riga) – in this case municipalities are responsible and for all payments and all actions.

Example of building refurbishment

Project – Riga, Celmu Street 5

The building was constructed in 1976. It is located in Mezciems district of Riga city. It is a type 464 prefab building. The building has no attic and there is a basement below the whole area of the building.

Main parameters of the building: number of floors – 5; number of apartments – 60; number of tenants – 151; heating area – 2972.20 m²; hot water – provided all year around.

Measures implemented: windows changed, m² – 541; walls insulated, m² – 2 023; top floor ceiling insulated, m² – 780; thermoregulation installed on each radiators, pieces – 190; heat energy meters installed on each radiator, pieces – 190; basement ceiling insulated, m² – 0.

Investments: total – 148 559.95 € (grant – 60 000 €).



Figure 1. Before and after project.

Measures implemented allowed to reach very substantial reduction of heat energy consumption – up to 46% in comparison to the heating season before project. The reduction of heat energy consumption in the second season after project implementation is a bit lower than in the previous heating season – 45%, because the total average temperature was lower. In the third season reduction of heat energy consumption is reached up to 55% in comparison to before project situation, but it can be explained with a bit higher average temperature in 2006/2007 heating season. In the fourth season reduction of heat energy consumption reached up 58% in comparison to before project situation, because in heating season 2007/2008 temperature in February was higher than in previous season and the consumption of heat energy was twice smaller.

Table 3. Heat consumption, MWh.

	X	XI	XII	I	II	III	IV	Total
Before project	32.72	43.95	74.34	91.98	83.02	48.88	10.33	385.22
Average temperature, °C	1.9	4.0	1.2	-6.4	-3.4	-1.7	7.3	
After project, (2004/2005)	13.64	27.96	34.49	33.00	39.81	45.58	11.94	206.42
Average temperature, °C	3.4	-0.4	1.1	0.0	-6.6	-7.4	2.7	
Difference	19.08	15.99	39.85	58.98	43.21	3.30	-1.61	178.80
After project, (2005/2006)	17.73	22.32	37.47	43.30	40.96	33.95	19.82	215.55
Average temperature, °C	3.6	3.4	-2.8	-7.0	-8.3	-5.3	2.0	
Difference	14.99	21.63	36.87	48.68	42.06	14.93	-9.49	169.67
After project, (2006/2007)	5.03	24.50	27.02	29.46	45.49	24.26	16.96	172.72
Average temperature, °C	8.5	4.2	4.0	-1.8	-11.0	3.0	6.0	
Difference	27.69	19.45	47.32	62.52	37.53	24.62	-6.63	212.5
After project, (2007/2008)	13.42	24.65	26.32	31.27	22.29	27.27	14.94	160.16
Average temperature, °C	5.9	0.3	0.5	-0.3	1.7	1.4	7.2	
Difference	19.3	19.3	48.02	60.71	60.73	21.61	-4.61	225.06

Specific thermal energy consumption of the building:

- before project (2003/2004) – 129.60 kWh/m²;
- after project (2004/2005) – 69.45 kWh/m²;
- after project (2005/2006) – 72.52 kWh/m²;
- after project (2006/2007) – 58.11 kWh/m²;
- after project (2007/2008) – 53.89 kWh/m².

Heat is provided by the JSC “Rigas siltums” (fuel – natural gas).

Table 4. Heat costs, €.

	€/MWh	Total costs, €	Costs, €/m ²
Before project	24.53	9 449.62	3.17
After project (2004/2005)	24.53	5 063.57	1.71
Difference	0.00	4 386.05	1.46
After project (2005/2006)	27.25	5 873.34	2.00
Difference	-2.72	3 576.28	1.17
After project (2006/2007)	32.01	5 529.60	1.86
Difference	-7.48	3 920.02	1.31
After project (2007/2008)	45.23	7 244.54	2.43
Difference	-20.7	2 205.08	0.74

Table 5. CO₂ emissions.

	t
Before project	96.00
After project (2004/2005)	51.26
Difference	44.74
After project (2005/2006)	52.00
Difference	44.00
After project (2006/2007)	42.98
Difference	53.02
After project (2007/2008)	40.34
Difference	55.66

CONCLUSIONS

In total 7 refurbished projects were analyzed in the paper: 1 project in Riga – Celmu str. 5; 4 projects in Broceni – Skolas str. 21 and 23, Lielcieceres str. 34 and 36; 1 project in Liepaja – Ganibu str. 135/141; 1 project in Salacgriva – Turgus str. 3.

Total emission reduction achieved in the first heating season (2004/2005) after the implementation of 5 housing refurbishment projects is 308 t of CO₂, but after heating season 2005/2006 (including 2 more projects) total emission reduction reached 469 t of CO₂. In the next heating season (2006/2007) all 7 housing refurbishment projects show total emission reduction of 553 t of CO₂ in comparison to before project data. In the heating season 2007/2008 the total emission reduction reached up 529 t of CO₂ in comparison to before project data.

Total heat energy consumption reduction in the first heating season was 771 MWh, but after the second heat season (2005/2006) it was 1198 MWh (including 2 new projects), but after the third (all 7 projects) it is 1428 MWh. After fourth heating season (2007/2008) total heat energy consumption reduction was 1377 MWh.

The reduction of necessary energy resources for heat generation, during 4 heating seasons, reached:

- ~ 187 500 m³ of natural gas,
- ~ 1546.32 t of woodchip.

Despite the fact that 2005/2006 heating season was colder than the previous season, the heat energy consumption has decreased. Obviously, people have started to use the opportunity to change the consumption themselves according to their needs. The October and November in this heating season were warmer than in previous season. The least heating season (2006/2007) was warmer on the whole, that's why all indices show high improvement. The

heating season 2007/2008 was warmer than previous season so the heat energy consumption has decreased.

Almost in all projects heat costs per m² have been reduced substantially – from 11 % up to 50%, but in comparison with previous heating season the costs per m² in heating season 2007/2008 have been increased.

DISCUSSION

- Project applicants faced a problem to reach at least 75% (now 51 %) apartment owners agreement to take loan and to start whole refurbishment of dwelling (it is required by the bank in case there is no any additional security provided);
- It is very difficult for inhabitants to agree to take loan for investments in common property. There are very different people that are living in the same house – for some of the planned payments are acceptable but for some are too high;
- Inhabitants are not ready to invest in common property and still do not realize that it is their common obligation;
- Projects required complex refurbishment of dwellings. That is correct from technical point of view but it requires also high investments. Not all inhabitants are ready for so big credit payments that are necessary to finance complex refurbishment;
- Inhabitants don't have collective borrowing experience therefore are very skeptic to participate and to take loan;
- It is a time consuming process – from project idea to real implementation.

Comparison of approaches:

Step-by-step:

- role of standard building refurbishment measures is crucial – to ensure that expectations on energy saving potential will be achieved (in opposite case it will be very difficult to convince inhabitants to take the next refurbishment steps);
- easier to convince inhabitants especially in case when total payment will not increase – energy savings fully cover loan principal and interest repayment;
- usually in long term perspective more costly and more time consuming than complex refurbishment.

Complex refurbishment:

- from technical point of view more appropriate approach;
- more difficult to convince inhabitants – payments usually increase.

REFERENCES

1. P.Shipkovs, G.Kaskarova, I.Purina, K.Lebedeva, M.Rubina, J.Golunovs, I.Niedrite, M.Jirgens. 2008. Energy Conservation in Household". Second International Association of Science and Technology for Development Africa Conference on Power and Energy Systems, AfricaPES 2008, 8-10, September, Gaborone, Botswana. 114-117 pp, CD proceedings.
2. P.Shipkovs, G.Kashkarova, K.Lebedeva, I.Purina, Z.Budjko. 2009. Energy Saving in Building Sector in Latvia. CISBAT 2009, Renewables in a Changing Climate from Nano to Urban Scale, Lausanne, Switzerland, 2-3 September, 2009. CD Proceedings, 143-148 pp.
3. Cabinet of Ministers of Latvia Law "Energy Performance of Buildings", 01.2009.
4. Cabinet of Ministers of Latvia Regulations Nr. 59 "State Budget co financing of energy efficiency activities in dwellings", 02.2008.
5. Statistical Yearbook of Latvia, 2008.