Introduction of Environmental Quality Management Procedures in the Housing Sector of Latvia

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ABSTRACT

This paper discusses the introduction of environmental quality management procedures in the housing sector of Latvia. One of the key measures required for the safe, rational use of energy in an environmentally responsible manner is the provision of instructions for the operation, maintenance, and use (OM&U) of building mechanical systems. Building codes dealing with OM&U issues are now being developed, for example, European pre-standards prEN12170 and prEN12171. Another component of environmental quality management is building energy rating systems. An energy rating scale can also be harmonized with the classification system used in the Green Building Challenge Tool, the aim of which is the stimulation of building sustainability. OM&U instructions and a building energy pass constitute verification documentation for both new and existing dwelling units.

The paper gives an example of OM&U instructions suitable for existing dwelling units and presents a theoretical basis for the development of a building energy rating scale.

INTRODUCTION

Latvia, with a population of less than 2.5 million, has 53.2 mil.m^2 of dwelling units. These are mainly multistory apartment buildings, 60% of which were built between 1960 and 1980. Energy consumption for these dwelling units takes at least 35% of the total primary energy consumption in Latvia, while the total energy consumption of the inhabitants (including gas and electricity) is estimated at 50% of the national energy consumption. Building systems in these units are generally in poor condition due to their age and the lack of proper maintenance. Ten years ago, all apartments belonged to the municipalities and received regular, although insufficient, maintenance. Now, nearly all apartments are privatized and, in spite of initial hopes, this has not improved the situation. There are no legal regulations that govern the relationship between flat owners, who often do not use a common language. Even if they do, most know little about the building or its systems due to a lack of documentation.

The paper describes some of the measures that have been taken in the introduction of an environmental quality management system for dwelling units. One of the measures needed for safety and energy management is proper operation, maintenance, and utilities (OM&U) instructions. Another measure is a building energy rating system and energy passes with voluntary building energy certification.

INSTRUCTIONS FOR OPERATION, MAINTENANCE, AND USE

Requirements of Latvian Legislation

The process of designing, constructing, and operating a building is regulated by the Latvian Building Code (LBN), which consists of several volumes. The LBN reserves the identification numbers in the LBN 410 series for OM&U codes that are now in the process of development. Preparation of Latvian OM&U codes follows European prestandards prEN 12170 and prEN 12171. These European prestandards are intended to be used for new building projects and renovations, but they can also be used for existing buildings in order to ensure that the building's documentation contains the necessary information.

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Latvian legislation stipulates that only acts that are approved by Saeima (the parliament of Latvia) or by the Cabinet of Ministers have legal power and must be followed by all persons. Therefore, the building codes in Latvia (unlike many EU countries) have to be approved by the Cabinet of Ministers. This procedure is time consuming and consists of the following steps:

1. Ministry of the Environment nominates its own specialists or special experts to develop a draft of LBN.
2. The draft is sent to various interested parties for considerations and comments.
3. After corrections have been made, the draft is sent for approval and comments to ministries and some other state institutions.
4. After the necessary corrections, the draft is submitted to the corresponding committee of the Cabinet of Ministers for examination.
5. If the committee approves the draft, it is delivered to the Cabinet of Ministers for approval, and only then does the building code have legal force.

Latvia, like other EU member countries, is planning to reduce the scope of the LBN and gradually adopt European standards CEN and ENV. In the future, the LBN will contain only the administrative and fire safety provisions as well as essential environmental and sanitary requirements. With respect to calculation methods, design, workmanship, and installation requirements, the LBN will reference appropriate CEN standards. These consist of mandatory standards (in the case of safety requirements) and voluntary standards (in the case of workmanship and installation methods). When this occurs, the processing of the LBN draft in the committees will be simpler since it does not require specific knowledge of the design process, but rather references CEN standards, which are not contested.

Currently, procedures for the commissioning of building systems are not established in Latvia. The law for commissioning is in the process of development as well as codes on OM&U instructions.

Contents of the OM&U Instructions

Contents of the OM&U instructions generally are made in accordance with standards prEN 12170 and 12171.

Each installed system must have a set of OM&U instructions, which must be prepared in a form appropriate for use by those concerned with the operation, maintenance, and use of building systems. OM&U instructions not only cover heating systems, as in prEN 12170, but also deal with domestic hot and cold water services, sewerage, and rainwater systems.

The OM&U instructions typically contain the following information, as specified by the system designer:

- A general description of the system. The description shall give information about the purpose and services for which the system was designed and intended.

Figure 1 *Apartment building of 602 series.*

- Plans showing the layout of the building, components, and appliances to guide those concerned with operation, maintenance, servicing, or repair of the building systems.
- Schematic plant or system drawings.
- A full description or other information with respect to concealed pipework and components and appliances that are considered maintenance free.
- Make, type, duty, and data on components and appliances.
- Commissioning information and data.
- Commissioning and balancing report.
- Operation, servicing, maintenance, and repair history of the heating system and its subsystems.
- An address list.
- Reference to applicable health and safety regulations, including risk assessment.
- Manufacturers’ data sheets.
- Cost control schedules for operation, maintenance, and repair.
- Any warranty conditions.
- Any specific component or manufacturers’ literature to which cross-reference is made in the OM&U instructions.
- Location where OM&U instructions are available, including archives.

OM&U instructions for existing dwelling units form the basis for improvements in maintenance as part of the environmental quality system.

Example of OM&U Instructions

An example (Kreslins et al. 2000) is provided for an eight-story apartment building (602 series) in Riga, as shown in Figure 1. The example does not cover all requirements in prEN 12170 and prEN 12171. Any part of the example may or may not be relevant in any particular OM&U instructions.

The OM&U instruction manual for this particular building consists of four parts. The first part is devoted to sewerage and rainwater systems, the second part to the hot and cold water systems, and the third part to the heating system. Schematic drawings are included that show connections to the town's sewer, water, and district heating systems, along with short descriptions of the building systems with drawings or photographs, equipment schedules, plus operation and maintenance instructions for each of these three parts. Examples of the drawings and the equipment schedule are shown in Figures 2 and 3 and in Table 1.

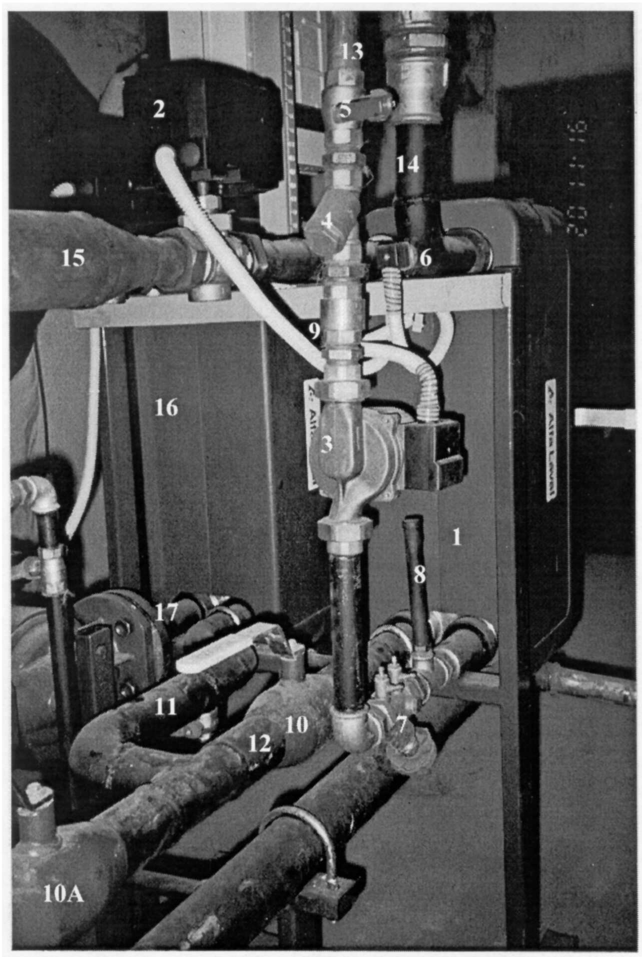

Figure 2 *Domestic hot water preparation unit.*

The fourth part of the manual contains maintenance control tables. The first table specifies the frequency of equipment examination (e.g., every day, once in a month, half a year, or a year). Equipment is numbered in the same order as in the previous parts of the manual. In other tables, control operations are grouped according to the frequency of examination. These tables contain an exact description of the control operations for each element in the system. At the end of the fourth part there are fault detection and remedy tables that describe the most common faults, possible causes, and remedial actions.

STIMULATION OF THE IMPROVEMENTS IN ENERGY CONSUMPTION

Building Energy Rating

Building energy rating schemes create awareness in the building's occupants and help to form a basis for the appraisal of investment profitability.

The rating scale proposed for buildings is made in accordance with the method described in environmental quality standard ISO 14000 and the belief that, from a sustainability perspective, the less consumption the better. It is not important whether the reason for performance is the result of a good quality building envelope and systems or the inhabitants' energy awareness. The proposed Latvian scale for building energy ratings is based on actual consumption, adjusted to the

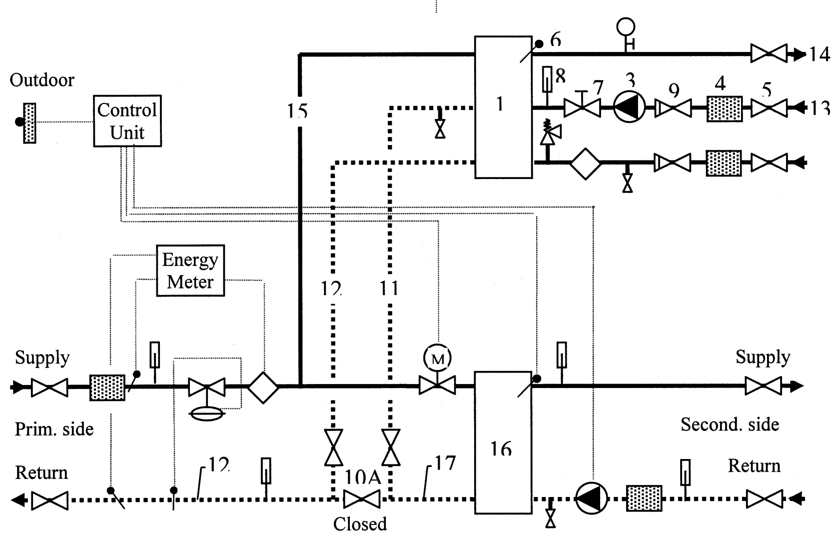

Figure 3 *Schematic diagram.*

TABLE 1
Sample Equipment Schedule

Building	Dwelling unit, Praulienas street Nr. 14, Riga	**System number**	**Date**
			November 1999
Type of system	Domestic hot and cold water	**Installation date**	**Sign.**
		1983-1984 / 1999	LL/KD
Location	See paragraph 2.2.1.		
Serves	The whole building		
Description and technical data	See paragraph 2.2.2.		
Components			
Designation	**No. photo/ diagram**	**Make**	**Data**
Heat exchanger for domestic hot water	1	Alfa Laval type CB76L-60M	320 kW, 70 to 30 / 5ºC to 55°C
Control valve and actuator	2	Danfoss type VM2 / AMV30	DN 32, kvs = 10, 230 V, 50 Hz
Circulation pump	3	DAB type 565/150	1 speed
Strainer	4		DN 25
Stop valve	5		DN 25
Temperature sensor for domestic hot water	6		
Balancing valve	7	TA type STA-D	DN 25
Thermometer indicating temperature of the circulating domestic hot water	8		
Check valve	9		DN 25
Stop valve	10	Naval	DN 50
Stop valve	10A	Naval	DN 50. Should normally be closed
District heating return pipe from the heat exchanger for heating to preheat the domestic cold water	11		DN 50
District heating return pipe	12		DN 65
Circulation pipe	13		DN 25
Domestic hot water pipe	14		DN 50
District heating flow pipe	15		DN 65 DN 32
Other items on the photo:			
Heat exchanger for heating	16	Alfa Laval type CB76-50H	324 kW, 118-70 / 65-90 °C
District heating return pipe from the heat exchanger for heating	17		DN 50

standard degree-days and standard level of occupancy, using Equation 1 (Kreslins and Belindzeva-Korkla 2000).

$$q_{st} = q_{s.h.} DD_{st} / DD + q_{d.w.} F / 30n \qquad \mathrm{KWh/m^2 \cdot year} \quad (1)$$

The numerical values of the scale are harmonized with the concept of the Green Building Challenge Tool, where levels range from 5 to –2.

- Level 5: Energy consumption 25% less than Level 3.
- Level 4: Energy consumption 10% less than Level 3.
- Level 3: Present best level that we assumed to be the present, normal level.
- Level 2: Present best level (Level 3) plus one-third of difference between Levels 0 and 3.
- Level 1: Present best level (Level 3) plus two-thirds of difference between Levels 0 and 3.
- Level 0: Common level of energy consumption—mean level of present real consumption.
- Level –1: Energy consumption 15% more than Level 0.
- Level –2: Energy consumption 30% more than Level 0.

Due to the lack of information about the present level of energy consumption for space heating and domestic hot water, it was necessary to conduct a study on the buildings' actual energy consumption patterns.

Evaluation of the Present Level of Energy Consumption

Until 1998, only theoretical calculations of energy demand were possible since building energy consumption was not metered. Now, energy received from district heating systems is measured in one of the following three ways: (1) with one energy meter for the whole building, (2) with two energy meters that separately measure space heating and domestic hot water consumption, and (3) energy consumption for space heating measured for each building, while consumption for domestic hot water is measured for a group of buildings.

The evaluation on actual energy consumption was made for the period October 1, 1998, to September 30, 1999 (Belindzeva-Korkla 2000). The heating period for this year (October through April) had 3831.2 degree-days (Celsius), which is 1.7% more than for the same period in a standard year (3766.8). Degree-days in both cases were calculated using a space temperature of +18°C. The study included 349 buildings in five different districts of Riga and consisted mainly of five- to sixteen-story apartment units built in the 1960s and 1970s. Some two- to four-story buildings of earlier construction were also included for comparison purposes.

The aims of the study were to determine actual total specific energy consumption, q, kWh/m^{2}year; specific energy consumption for space heating, q_h, kWh/m^{2}year; and specific energy loss, h, W/m^{2}K, calculated for 1 m^2 of heated built-in area of the buildings.

Results of the study showed:

- Real specific heat loss for the same type of buildings varies ±25% and the rating scale cannot be based on calculated heat loss due to the big differences in the quality of construction.
- Total specific energy consumption falls in a wide range, 160 to 350 kWh/m^{2}year, with the majority if buildings in the range of 220 to 240 kWh/m^{2}year. The cumulative distribution of total energy consumption is shown as Line 1 at Figure 4.
- Space heating is around 56% of total energy consumption, or 120 to 150 kWh/m^{2}year.

Consumption for space heating was not as high as expected, with the specific heat loss being 1.2 to 1.6 W/m^{2}K. This is due to the relatively short heating season (October through April) and the fact that most dwelling units are heated to the minimum acceptable temperature. The fraction of domestic hot water to total energy consumption is higher than normal for Northern European countries due to higher occupant densities (in our study the mean level of occupancy *F/n* was 24.49 m^2/person).

Two main considerations in the development of the rating scale and calculation of numerical values were the following:

- The domestic hot water fraction is rather high and has to be taken into account. It was adjusted to the standard level of occupancy of 30 m^2 per person.
- Space heating has to be adjusted to 4688.3 degree-days, which would be expected in economically favorable conditions (heating period from September till May, mean outside temperatures of standard year, space temperature + 20ºC).

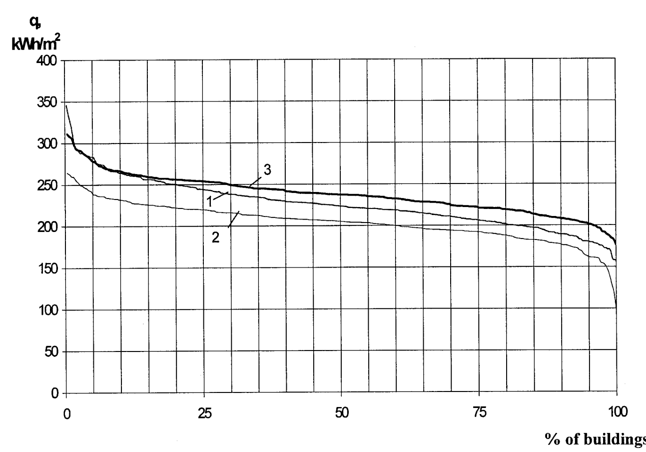

Figure 4 *Cumulative distribution of actual (line 1) and rating heat consumption in present (line 2) and favorable (line 3) economic situation.*

TABLE 2
Normative Coefficients of Thermal Resistance and U-Factors in Latvia and Other Countries

	Coefficient	Latvia		Denmark	Norway	Sweden	Finland	Germany
		Till 1991	1991					
Walls	U, W/m^2K	0.75	0.5 to 0.33	0.2	0.22	0.22	0.28	0.50
	R, m^2K/W	1.33	2.0 to 3.0	5.00	4.55	4.55	3.57	2.00
Roofs	U, W/m^2K	1.25	0.4 to 0.25	0.15	0.15	0.20	0.22	0.22
	R, m^2K/W	0.8	2.5 to 4.0	6.67	6.67	5.0	4.55	4.55

TABLE 3
Normative Specific Heat Loss of Dwelling Units

Number of floors	1-2	3-4	Above 5
Specific heat loss, h, W/m^2K	1.2	0.9	0.72

Energy consumption of Level 0 was found as the standardized specific energy consumption using Equation 1 and the results of the study, i.e., mean total specific heat consumption—230 kWh/m^2year; fraction attributable to space heating—56%; fraction attributable to domestic hot water consumption—44%; degree-days of the rating year—3831.2; mean level of occupancy F/n = 24.49 m^2/person. So the numerical value for Level 0 is

$$0.56 \times 230 \times (4688.3)/(3831.2) + 0.44 \times 230 \times (24.49)/(30\} = 240\ kWh/m^2 year.$$

Figure 4 can be used to predict how often the building's specific energy consumption will be greater than some specified level or the percentage of the buildings that exhibit consumption within some specified limits. Line 1 shows the cumulative distribution of actual building specific energy consumption for the buildings in the case study. Standardized specific energy consumption was calculated for the buildings using Equation 1 for two different situations—the present economic situation (3766.8 degree-days) and an economically favorable situation (4688.3 degree-days). The cumulative distribution of standardized, specific energy consumption at the present economic situation is shown as Line 2 in Figure 4. The cumulative distribution of standardized, specific energy consumption for the economically favorable situation is shown as Line 3.

Evaluation of the Best Present Level of Heat Consumption

Energy consumption of Level 3 may be estimated from normative values for dwelling units.

Thermal insulation levels of the existing apartments in Latvia are much lower than in countries with comparable climatic conditions. Stricter building regulation requirements were adopted in 1991, but they are very mild compared to some other countries, especially considering that the Latvian climate is colder (Table 2).

This situation will be changed when the new Latvian Building Code (LBN 002-01, Thermal Performance of Building Envelope) is approved. Although the code gives recommended U-factors for building envelopes, it also permits modifications if the specific heat loss of the whole building envelope is not higher than the specific loss calculated with the recommended values. To simplify the calculations, the narrative provides values for building specific heat loss that are shown in Table 3.

Best present specific energy consumption for space heating may be calculated from the Equation 2 using normative specific heat loss given in Table 3.

$$q_{s.h.} = 0.024 \cdot h \cdot \sum D(\theta_i - \theta_o), \text{kWh/m}^2 \cdot \text{year} \tag{2}$$

The value is calculated as follows:

$$0.72 \times 0.024 \times 4688.3 = 81\ kWh/m^2 \cdot year.$$

It was already established from the case study that space heating is responsible for 56% of total energy consumption, so the best present total specific heat consumption (Level 3) is

$$81 \text{ x } 100/56 = 145\ kWh/m^2 \cdot year.$$

The Rating Scale

The rating scale for different classes and levels is presented in Table 4.

The fourth column in Table 4 shows how many buildings of the case study would have the particular rating. Evaluation is done using line 3 in Figure 4. These results make sense given that in the scale development process for the consumption of Level 3, we took the consumption corresponding to the level of the new building code.

To stimulate construction of improved dwelling units relative to LBN 002, a voluntary system of building energy certification is proposed. Building energy certification can be received if the thermal characteristics of the building envelope are a specified amount better than that required by the new building code. A gold energy certificate can be received if the building's energy consumption corresponds to the consumption of the Level 5 (i.e.,–109 $kWh/m^2 \cdot$year), while the silver energy certificate will be issued to the buildings with annual energy consumption of not more than 130 $kWh/m^2 \cdot$year.

TABLE 4
Rating Scale of Heat Consumption

Class	Level	Consumption, kWh/m^{2}year	Frequency of occurrences in present cumulative distribution
1	2	3	4
A (excellent)	3	□ 145	0%
B (very good)	2	145.01 to 77	0%
C (good)	1	177.01 to 208	6%
D (fair)	0	208.01 to 240	41%
E (poor)	-1	240.01 to 276	48%
F (very poor)	-2	> 276.01	5%

It is believed that the proposed rating scale for building energy effectiveness represents the macro-economic interests of the state. For other purposes, such as for marketing and evaluation of investment profitability, it is necessary to know the performance of the particular dwelling unit within its own group. Studies of building energy consumption have shown that space-heating consumption depends heavily on the type of unit and that buildings of each type display significant variations (for example, 103 Series dwelling units display a consumption range of 87 to 126 kWh/m^2·year, while five-story brick buildings built in the 1960s range from 154 to 176 kWh/m^2·year). It is also useful to differentiate between buildings based on space-heating consumption. This can be done using three additional indices—good, average, and bad. Numerical values are noted differently for each particular group of buildings. Such subrating characterizes possibilities for improvements in energy effectiveness without major reconstruction of the buildings. So, rating D3 would mean fair total heat consumption but bad space heating effectiveness for the building.

Building Energy Passport

The building energy rating should be written in a building energy passport that is part of building verification documentation as well as OM&U instructions. The building energy passport is filled in by the energy auditor who has to evaluate actual space temperatures during the heating season and determine the number of degree-days for a particular year, evaluate the actual number of inhabitants and the distribution between domestic hot water and space heating consumption if they are not measured separately, and make a preliminary audit analyzing the most obvious factors that had influenced the rating and note them in the rating statement.

CONCLUSIONS

The proposed system of environmental quality management for dwelling units consists of two main elements that together form a verification documentation for existing and new dwelling units. These elements are OM&U instructions and a building energy passport. The energy rating scale is harmonized with the concept of classification in GBTool, the main aim of which is stimulation of building sustainability.

NOMENCLATURE

D = number of days in a month

DD = degree-days of heating period in rating year

DD_{st} = degree-days of standard year in favorable economical conditions

F = heated built-in area, m^2

h = building specific heat loss, W/m^{2}K

n = number of inhabitants, persons

q = total specific heat consumption, the sum of $q_{d.w}$ and $q_{s.h.,}$ kWh/m^2 year

$q_{d.w.}$ = measured consumption for domestic hot water in rating year, kWh/m^2 year

$q_{s.h.}$ = measured specific consumption for space heating in rating year, kWh/m^2 year

q_{st} = rating specific heat consumption, kWh/m^2 year

θ_i = mean monthly inside air temperature, ºC

θ_o = mean monthly outside air temperature, ºC

30 = standard occupancy level, m^2/ person

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