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HEAT ENERGY AND WATER CONSUMPTION IN APARTMENT BUILDINGS

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Abstract. Specific heat energy consumption for space and water heating in typical apartment buildings in Tallinn is described. Hot and cold water consumption data is presented and energy conservation measures in apartment buildings are considered.

Key words: heat energy consumption, water consumption, energy conservation.

1. INTRODUCTION

There have been great changes in Estonia in recent years. The same applies to energy consumption in apartment buildings. Because of widespread measurement of heat energy and water consumption, the consumption has considerably changed. In this situation even some years old investigation results may give an inaccurate picture about energy and water consumption [1]. The aim of this investigation is to characterize the contemporary situation in heat energy and water consumption in a Tallinn living district.

2. INVESTIGATED BUILDINGS

The object of this investigation was 113 panel residential buildings in Tallinn Mustamäe District. Table 1 shows the distribution of the buildings according to the number of apartments and floors.

Table 1. Distribution of the buildings according to the number of apartments and floors

Number of floors	Number of apartments	Number of buildings
5	30	11
5	60	34
5	80	11
5	90	21
5	119	12
9	72	7
9	144	7
9	216	10
		Total 113

All investigated buildings have modern automated heating substations and are equipped with contemporary heat meters as well as with hot and cold water meters. Heating systems are balanced one-pipe systems, ventilation is natural. Domestic hot water systems are equipped with circulating pipes and towel dryers. Degree-days are calculated on the basis of [2] and on the data of the Harku meteorological station. Buildings were erected in 1965–1975. The approximate values of the thermal transmittance of the envelope elements of the investigated buildings and construction code values are the following, W/(m^{2}K):

	Investigated buildings	After [3]
External walls	1.0–1.2	0.28
Roof-ceilings	0.7–0.9	0.22
Windows	2.7–2.9	2.1

Air change rate in most of the investigated buildings was in the interval 0.2–0.8. For apartment buildings acceptable air change rate is 0.5.

3. HEAT ENERGY CONSUMPTION

Heat energy consumption in apartment buildings was determined on the basis of factual consumption in 1999. The average specific heat energy consumption in the investigated 113 residential buildings was 223 kWh/m^2 per average year. In different buildings the specific heat consumption was within 180–320 kWh/m^2 per average year (Fig. 1). Average energy consumption Q per average year is calculated as

$$Q = Q_1 S/S_1, \tag{1}$$

were Q_1 is energy consumption in the investigated year, S is the number of average heating degree-days (calculated using data for 26 years), S_1 is the number of heating degree-days in the investigated year 1999.

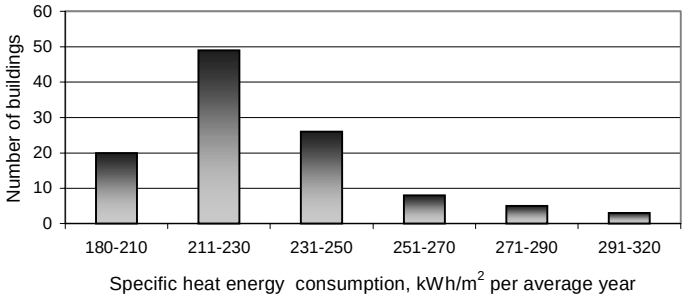

Fig. 1. Distribution of buildings according to specific heat energy consumption.

Using the factor 3.9 (the average ratio of volume and general area in the investigated buildings) for transition from m^2 to m^3, the average heat consumption in the investigated buildings is 57 kWh/m^3 per average year. This specific consumption is close to Finland's specific heat consumption in average apartment buildings constructed in the years 1960–1970 [4].

General heat energy and domestic hot water consumption was measured in all investigated buildings. Therefore it was possible to obtain specific heat energy consumption for space heating (Fig. 2) and specific energy consumption distribution for water heating in different buildings (Fig. 3). Water heating made 24% of the whole heat energy consumption. Specific heat energy consumption for domestic hot water heating is determined according to the average monthly temperatures of the cold water; the average is 53 kWh/m^2 per year. For the investigated apartment buildings, specific heat energy consumption for space heating was 170 kWh/m^2 per average year. To characterize specific energy consumption for space heating in different climatic areas, energy consumption in Wh/m^2 per degree-day is used. In the investigated buildings the average energy consumption was 41 Wh/m^2. This is close to the results calculated by Matrosov for typical 9-storey apartment buildings in Russia [5]. This key number for Germany is 44, for Denmark – 33, and for Sweden – 27 Wh/m^2 per degree-day [6].

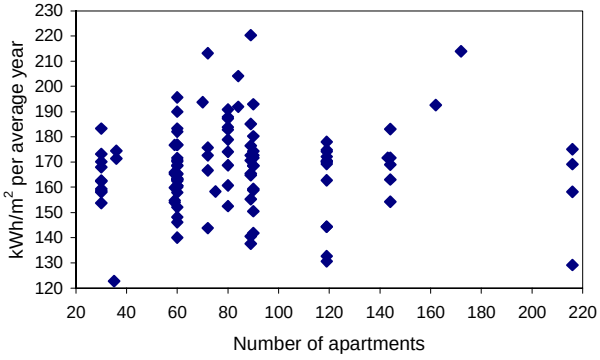

Fig. 2. Specific heat energy consumption for space heating in investigated buildings.

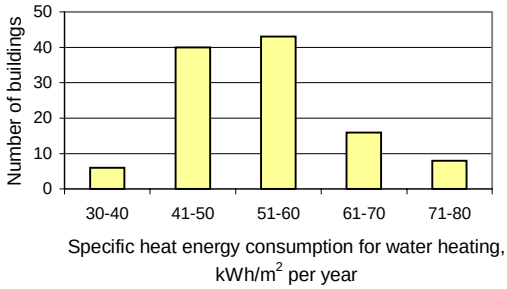

Fig. 3. Distribution of buildings according to specific heat energy consumption for domestic hot water heating.

We can see that differences in energy consumption in typical apartment buildings are very high. The main reasons for that are differences in domestic hot water consumption, air exchange, adjusting of controllers in heat substations, space heating systems construction and balancing quality, and in building constructions.

Heat energy consumption for domestic hot water supply was calculated on the basis of hot and cold water temperatures and water consumption data. Using circulating water and room temperatures and construction parameters of towel dryers, energy consumption by towel dryers in bathrooms was calculated. Variation of all the three components of energy consumption through the year are presented in Fig. 4. In summer, space heating means heat losses of pipes of the domestic hot water system.

We can see that heat energy consumption by towel dryers is practically constant during the year. Heat energy consumption by water heating depends lightly on the outside temperature.

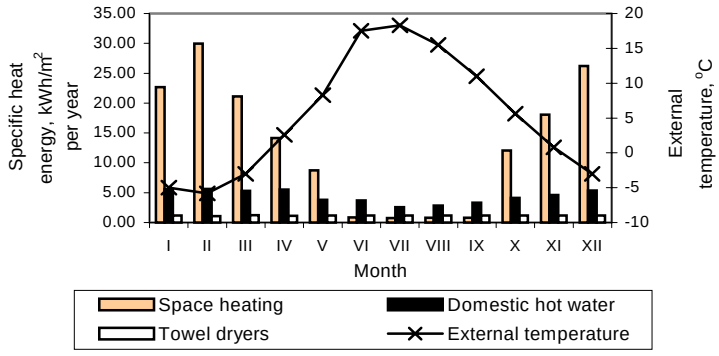

Fig. 4. Heat energy consumption for space heating, domestic hot water, and towel dryers through the year.

4. DOMESTIC HOT WATER CONSUMPTION

The water meters installation in apartments has considerably decreased the domestic hot water consumption. The same is valid for cold water. The cold and hot water consumption in investigated buildings through the year is given in Fig. 5. Average domestic hot water consumption is 55, that of the cold water 72, and the total 127 l per person per day. In the last 6 years the water consumption has decreased about twice and today is relatively low. According to Seppänen [7], in Finnish apartment buildings domestic hot water consumption is 85 l per person per day.

Domestic hot water consumption is 43% of the whole water consumption. Figure 6 characterizes the distribution of buildings according to domestic hot water consumption l/d per person (for Mustamäe district the average apartment area per person is 21.4 m^2). The influence of the number of apartment water meters on domestic hot water consumption is shown in Fig. 7. We can see that the number of apartment water meters and the domestic hot water consumption have a strong negative correlation.

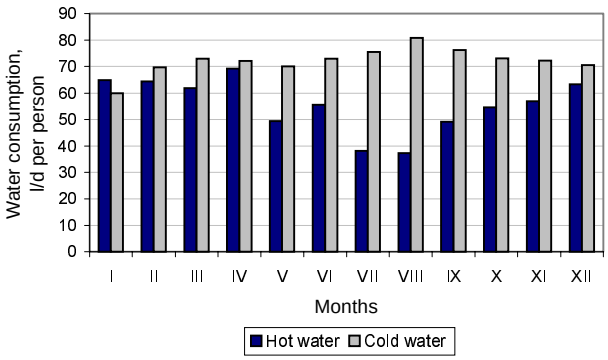

Fig. 5. The cold and hot water consumption in investigated buildings through the year.

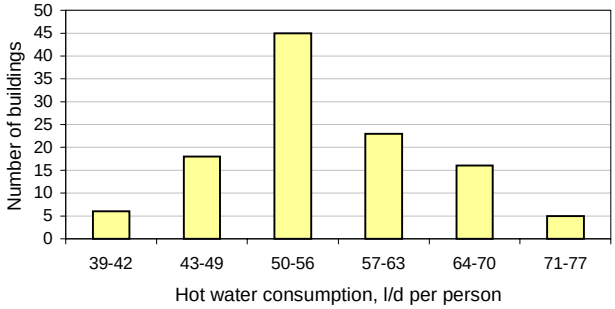

Fig. 6. Distribution of buildings according to domestic hot water consumption.

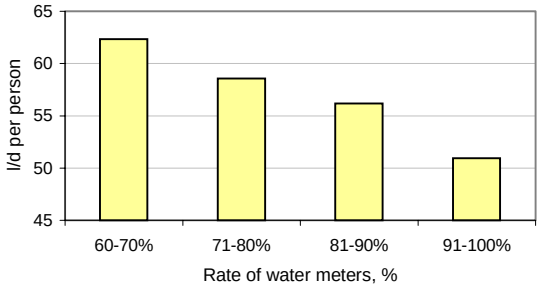

Fig. 7. The influence of the number of apartment water meters on domestic hot water consumption.

5. ABOUT HEAT ENERGY CONSERVATION

Heat energy conservation measures in residential buildings can be divided into two groups. The first group of measures with relatively short payback time (simple payback time until 7 years) is the following:

– control of the space heating systems supply water and domestic hot water temperatures;

– balancing of the space heating system;

– thermal insulation of the distribution tubes;

– installation of thermostats on radiator valves;

– tightening of windows (for apartments with high air exchange rate);

– measurement of the consumption.

The second group of measures has a long payback time, but in addition to energy conservation these measures give the possibility to rise the operating level or prolong the lifetime of all the building:

– adjustment of the domestic hot water circulation system (water conservation);

– renovation of roofs;

– renovation of end walls and facades (thermal insulation prolongs lifetime of panels and improves microclimate);

– replacement of outer doors (higher security);

– replacement of water taps (water conservation);

– renovation of windows (outdoor noise reduction).

In practice, apartment buildings with different inhabitants, different adjustment of controllers in heat substations and different construction and balancing quality of heating systems, have great differences in heat energy consumption.

6. CONCLUSIONS

The specific heat energy consumption in investigated apartment buildings was 223 kWh/m^2 per average year. This is close to the specific heat energy consumption in Finnish average buildings, erected in years 1960–1970. The

average specific heat energy consumption for water heating was 53 kWh/m^2 per year (24% of all energy consumption in an average year). Domestic hot water consumption was 55 and general water consumption 127 l per person per day. These numbers are lower than in Finland. The domestic hot water part in water consumption was 43%. In the investigated buildings 82% of apartments were equipped with water meters. Heat energy consumption in apartment buildings depends strongly on the residents lifestyle. Some very simple measures, for example water consumption measurement in apartments, give essential energy and water consumption decrease. As every building is unique in some way, for successful solution of the energy conservation problems, detailed consumption analysis is important.

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SOOJUSENERGIA JA VEE TARBIMINE KORTERELAMUTES

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On uuritud soojusenergia tarbimist kütteks ja vee soojendamiseks Mustamäe paneelmajades Tallinnas. Samuti on toodud andmed sooja ja külma vee tarbimise kohta ning loetletud soojusenergia kokkuhoiu meetmed.