

Measurements of water use in eight dwellings, by quantity and time

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Abstract

Reducing tap water consumption has considerable potential for reducing overall environmental impact. It not only saves fresh water, but also gives significant savings of energy that would otherwise have been needed to heat hot water. However, in order to improve the energy efficiency of building services systems and to help occupants act more energy-efficiently, more knowledge is needed on how water is used in our homes. Today, we actually know very little about usage patterns from one tapping point to another, or the division between cold and hot water use, and this study aims to help provide appropriate information.

Measurement have been made of hot and cold water use at each tapping point in eight ordinary dwellings: four apartments in apartment buildings, and four single-family houses. The compositions of the households were basically the following categories; single, young couple, middle-aged couple and family with children.

This paper presents an evaluation of the first measurement week of tap water use in the eight dwellings. The initial results show the following division of tap water use:

- wash basin: 23 %
- shower/bathtub 38 %
- kitchen sink 39 %

About 57 – 60 % of the total water quantity is hot water (note that cold water for toilet flushing or for laundry is not included

in the total water use). The proportions between tapping points are very similar for the dwellings in the apartment buildings and single-family houses, but overall daily water consumption is considerable higher in the multi-family houses.

Introduction

Decreasing our domestic water use not only saves fresh water, but also saves energy that is needed to heat the water to hot water. Domestic water conservation measures are therefore not only economical but also important in order to protect our environment. Effective measures include changing to more modern taps, such as single-lever mixer taps and thermostatic mixers, improving the building services systems that heat and distribute the tap water, or measures intended to influence users towards more energy-efficient behaviour. The average per-capita use of water in Sweden is between 140-250 litres/day. However, there is a considerable potential for saving, as shown (for example) in Wahlström 2000, where changing tap water equipment in a multifamily building resulted in a reduction in water use of more than 25 %.

Some measures will, however, be more or less successful than others. In order to be able to chose between different measures, to improve measures and to estimate how effective a measure will be, knowledge is needed of how domestic water is used in our homes. With this knowledge, it will be possible to design our building services systems to be more energy-efficient, and to help occupants to act in a more energy-efficient manner. This paper describes patterns of tap water use, and does not discuss different savings methods.

Today, there is very little knowledge about tap water use in terms of patterns during the day, the division between cold and

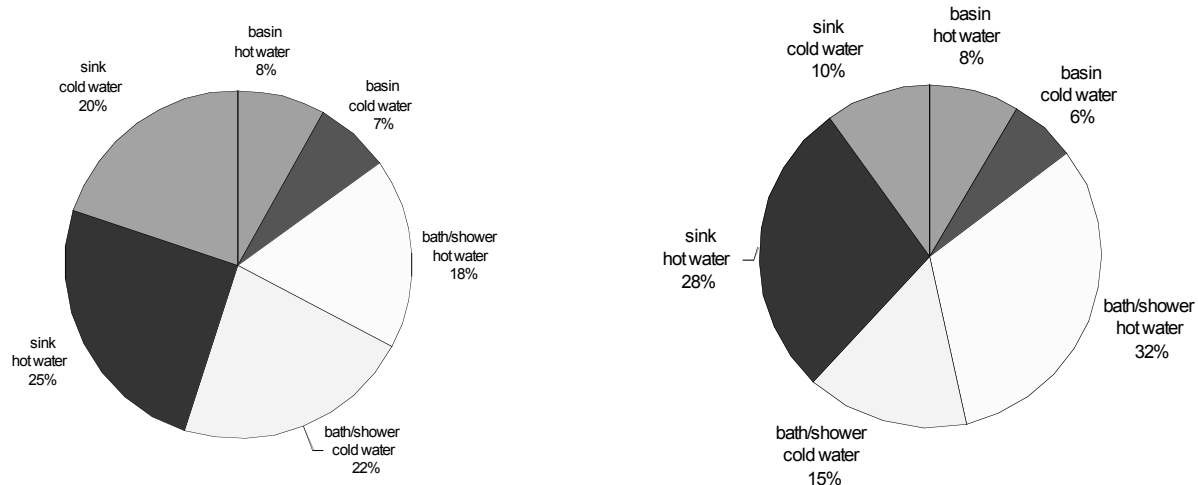


Figure 1. Division of tap water use between tapping points in two Swedish investigations. Left: Holmberg, 1981. Right: Wahlström, 2000.

hot water use or how water use is divided between different tapping points. Two investigations have been carried out in Sweden with the aim of describing water use between hot and cold water and different tapping points. The first was carried out in five two-room flats with a total of eight tenants, by Holmberg in 1981. The second one was carried out in two flats with a total of four tenants, by Wahlström in 2000. The flats have the following tapping points: bath and shower, basin, and kitchen sink, and the results are shown in Figure 1.

The proportion of hot water in the latter investigation is considerable larger, at 68 %, than in the 1980s investigation, which found a hot water proportion of 51 %. (Note that cold water for toilet flushing or for laundry is not included in the total water use.) Another difference is the quantity of daily hot water use: the 1980s investigation found 74 litres per person per day, while the 2000 investigation found only 44 litres per person per day. Hultström et al. 2005 presents results from an investigation of total hot and cold water use in apartment buildings with a total of 2187 occupants. This investigation also found a

high proportion of hot water use, at 44 %, and a daily hot water use of 87 litres per person, but in this case the water used for flushing the toilet and for laundry was also included in the total water quantity.

However, it is difficult to draw conclusions about hot water use today, or about water use between tapping points, from these investigations, and there is a need for more knowledge. The present investigation therefore aims to increase this knowledge by measuring tap water use in eight dwellings.

Measurement equipment and program

Water use at all tapping points was measured in all dwellings over a period of six months. The measurements were made continuously and stored every 10th minute. Over a seven-day period, measurements were made with a shorter time interval of one minute. This was done three times, in order to catch tapping cycles in different seasons; at the beginning, the middle and the end of the total measurement period.

In the single-family-houses, measurements were made in the utility room and of the individual washing machines. In two of the apartment buildings, additional measurements were made of the buildings' total cold and hot tap water use, and of water use in the common laundry rooms. The hot water temperatures at each tapping point were measured at the beginning and end of the total measurement period.

In all dwellings, hot and cold water use was measured at all tapping points. For the apartments in the apartment buildings, measurements were made at the sink, basin and shower/bath, while additional measurements were made in the single-family houses in the second WC room and in the utility room etc. Cold water consumption in the WCs was not measured. The measurements were made with 70 Macnaught M4ARP-1 flow meters, with an uncertainty of measurement of +/- 1 %. All flow meters were calibrated, with traceability to national standards, by SP Technical Research Institute of Sweden. The total uncertainty of the measurements of water consumption is less than 4 %.



Figure 2. Two Macnaught flow meters mounted on the cold and hot water pipes below a basin.

Table 1. Number of person in different age groups living in the dwellings

Category of dwelling	0-12 years	13-17 years	17-30 years	30 – 64 years	Over 64 years
Family	2			2	
Young couple			2		
Middle age couple				2	
Single				1	
Family	2	1		2	
Middle-aged couple with grown-up child			1	2	
Middle-aged couple				2	
Single					1

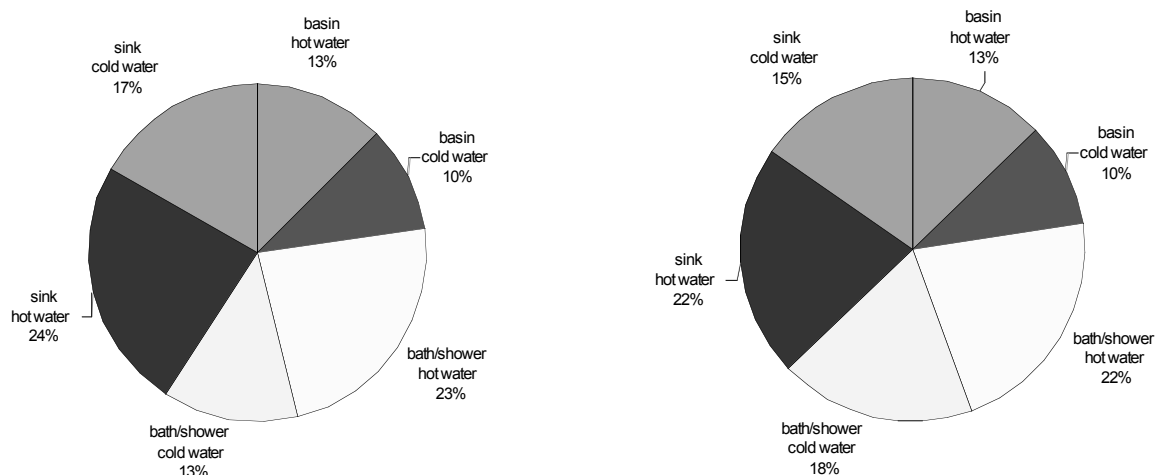


Figure 3. Division of tap water consumption between tapping points. Left: the result from the four flats in the apartment buildings, and Right: the results from the four single-family houses.

This paper presents only a first evaluation of the first measurement week of ordinary tap water use in the eight dwellings. The evaluation does not include the two multi-family houses’ total cold and hot tap water use, water use in the common laundry rooms, or in the utility rooms or individual washing machines in the one-family houses.

Selection of the eight dwellings

Selection was made in conjunction with the statistics agency in Sweden, “Statistics Sweden”, aiming to select households representative of different types of families in combination with the type of house or apartment in terms of age and location. Although it is difficult to achieve a truly representative selection (in statistical terms), we have tried to achieve as varied a selection as possible. However, for practical reasons, the geographical area was limited to the Lake Mälaren region. In total, there are eight households in the project, divided into four apartments in multi-family houses, and four single-family houses. The compositions of the households were planned to be in the following categories: single, young couple, middle-aged couple and family with children. However, it was not possible to find a young couple living in a single-family house, and so that category was changed to a middle-aged couple with a grown-up child. The compositions of the dwellings are shown in Table 1.

Results

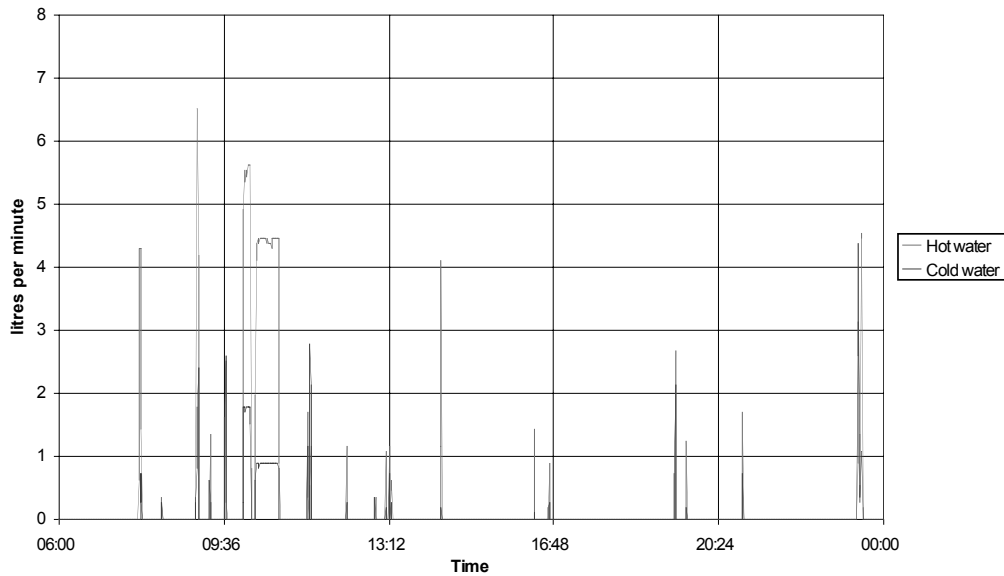
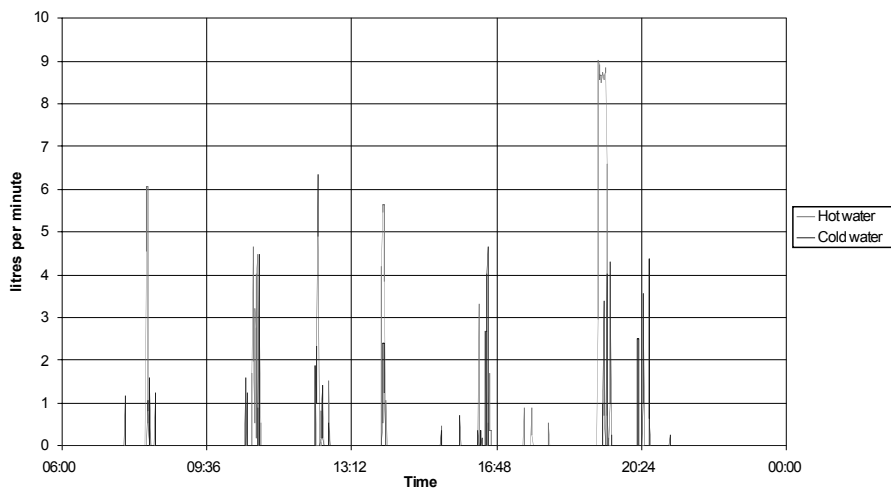
The division of tap water use between tapping points from the first measurement week are shown in Figure 3. The apartments have the following tapping points: bath and shower, basin and kitchen sink, while additional showers or extra basins has been included in the results for the single-family houses. The hot water proportion is 60 % in the multi-family houses, and 57 % in the single-family houses. This is equivalent to 3,2 kWh per day and person in the multi-family houses, and 1,8 kWh per day and person in the single-family houses. Daily water use per person at different tapping points is shown in Table 2. Figures 4 and 5 are the tap water patterns over an 18-hour period for a family with two children living in an apartment building.

Discussions, conclusions and further work

The evaluation does not include the two multifamily houses’ total cold or hot tap water use, water use in the common laundry rooms, water use in the single-family houses’ utility rooms or the individual washing machines’ water use, because it is impossible to draw conclusions from laundry water use after only one week of measurements. These particular uses of water have also been excluded in order to make the water use between apartments in multi-family houses and single-family houses comparable.

Table 2. Daily per-person water use at different tapping points (litres per person and day)

Dwelling	Shower		Kitchen sink		Basin		Total hot water use	Total water use
	cold	hot	cold	hot	cold	hot		
Multi-family houses	11,0	18,7	13,3	19,3	8,4	11,7	49,7	82,4
Single-family houses	10,3	11,8	6,9	11,3	5,1	5,6	28,7	50,8

**Figure 4. Tapping pattern at the basin over 18 hours.** For a family with two children living in a flat in an apartment building.**Figure 5. Tapping pattern in the kitchen over 18 hours.** For a family with two children living in a flat in an apartment building.

Since this paper presents only a first evaluation of the first measurement week, it is possible only to draw preliminary conclusions about the results. The daily hot water use per person, as found in this investigation, is similar to that found by Wahlström in 2000. Hot tap water use in multi-family houses in 2000 was about 30 % lower compared than as found in the 1980s investigation. At the same time, Hultström et al. 2005 presents data showing hot tap water use about 70 % higher than in this investigation. These differences may be due to water use in utility rooms and for laundry being included in the inves-

tigation made by Hultström et al. 2005, but being excluded in the present evaluation. The differences may also depend on the presence of the metering equipment itself, in that the occupants of the dwellings are unconsciously reminded of the measurements and modify their normal behaviour.

Division of tap water between tapping points shows a similar pattern between the previous investigations and the present one, except that the present investigation finds a larger proportion used in the hand basin. A comparison between water use in the multi-family houses and single-family houses shows that

the proportions between tapping points are very similar, while the daily water consumption is considerable higher in the multi-family houses. It is well known that total tap water use is normally less in single-family houses than in multi-family houses, which might depend on different behaviour patterns due to the mode of payment. The results from the present investigation, showing that it is the overall use at all tapping points that is less, might be an important point for further research and analysis on how single-family houses' behaviour could be transferred to multi-family houses.

The measurements will continue during the spring of 2007, after which the project's full results will be presented in additional reports.

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