Improving the Possibilities to Monitor Energy Consumption at Home

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SUMMARY

Inhabitants have low possibilities to monitor their energy and water consumption. The energy and water meters are typically read only once a year in Finland. The monthly bills are based on estimated consumption, i.e. the consumption of the previous year. A quantitative interview survey with a sample size of 3,094 people was performed to study attitudes and opinions about energy conservation and energy monitoring. The results show that 63% of the Finns think that it is very important or important to improve the possibilities to monitor energy consumption at home. A new prototype for monitoring energy consumption was developed at VTT. It gives occupants real time feedback on their energy consumption and the costs. In addition to the total consumption and costs, the prototype is able to present electricity consumption and costs of each device. The target is to create a system that gives occupants relevant information in a way that is easy to understand. The system is installed in two experimental houses.

INTRODUCTION

Inhabitants have low possibilities to monitor their energy and water consumption. In Finland, the monthly bills are based on estimated consumption, i.e. the consumption of the previous year, because the energy and water meters are typically read only once a year. This means that a household receives an additional bill or is paid after the meters are read. Some households may then get a bad surprise: a newspaper article [1] told about a family that received an additional 1800 € water bill.

Manual reading of energy meters will be replaced with remote reading in future. In Sweden, a new law demand monthly reading of energy meters from 1st of July 2009. Also in Finland and other countries, remote reading of energy and water meters is becoming more and more common. At first, remote reading becomes common in densely populated areas and apartment buildings. Remote reading will make at least some improvement in our possibilities to monitor consumptions.

The aims of our work are to study attitudes and opinions of Finns about household energy conservation and energy monitoring, and to develop a new prototype for monitoring energy consumption.

METHODS

Attitudes and opinions of inhabitants about energy conservation and energy monitoring were studied by a quantitative interview survey with a nationally representative sample. The target group of the study was the population of Finland. The interviews for the survey were carried

out by telephone (computer assisted telephone interview, CATI). A random sample of the Finnish population aged between 15 and 74 was selected with quotas set according to gender, age and province. The total number of respondents was 3,094. A well-known Finnish data collection agency (Taloustutkimus Oy) was responsible for the practical realisation of the telephone interviews according to its quality system. The interviews were performed in November and December 2004.

In addition to the quantitative interview survey performed, a new prototype for monitoring energy consumption was developed in this work.

RESULTS OF THE INTERVIEW SURVEY

The results of the interview survey are presented in Figs 1-4. Fig. 1 shows that people think that it is important to save energy at home. 82% of the respondents think it is very important (5) or important (4) to save energy at home. Own strive to save energy is, however, somewhat lower (Fig. 2).

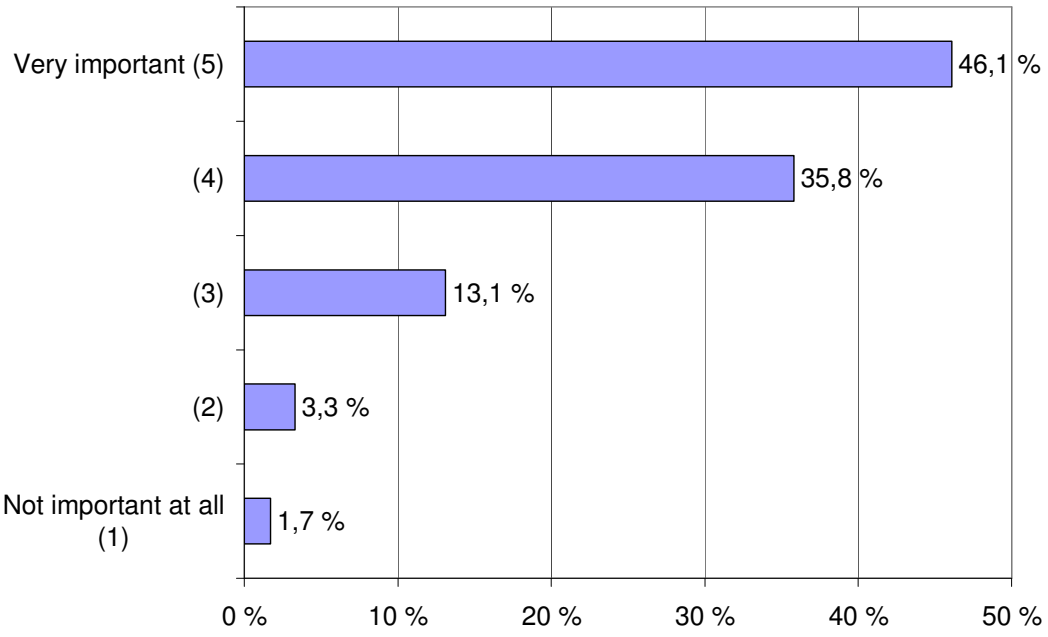

Figure 1. Importance to save energy at home (N=3075, mean: 4.2).

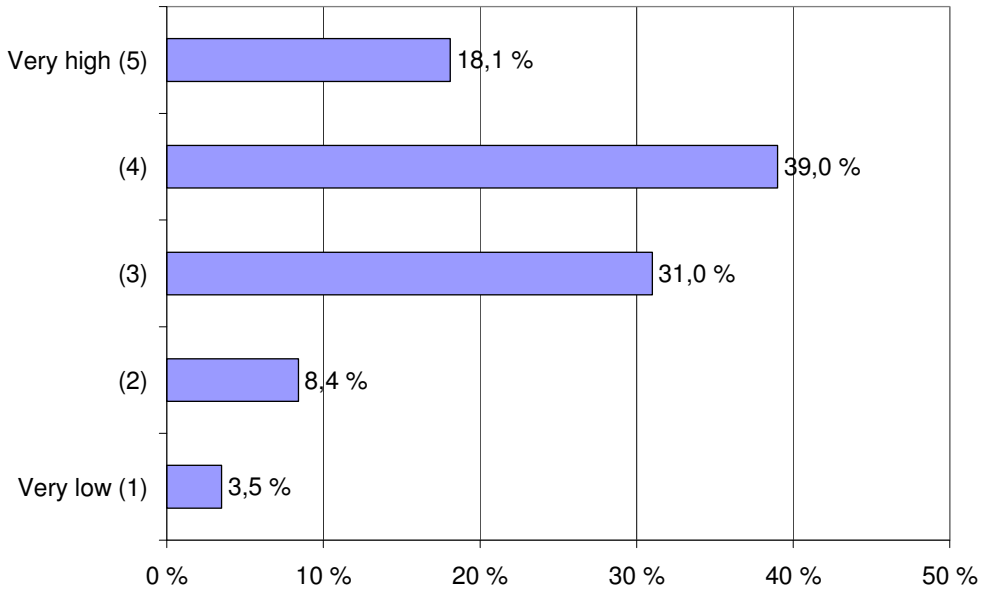

Figure 2. Own strive to save energy at home (N=3067, mean: 3.6).

People think their own actions have an influence on energy consumption (Fig. 3). Mean value is 4.0 in a scale from 1 to 5 (1, very low, … 5, very high).

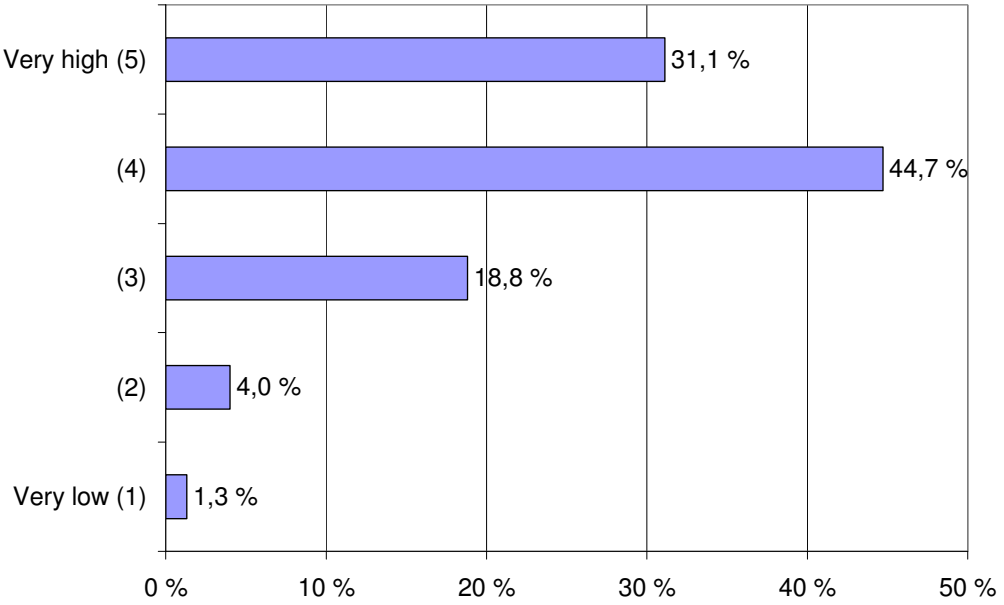

Figure 3. Idea of inhabitants' influence on energy consumption at home (N=3015, mean: 4.0).

Fig. 4 shows that 63% of the Finns think that it is very important (5) or important (4) to improve the possibilities to monitor energy consumption at home. Only 6% think that it is not important at all.

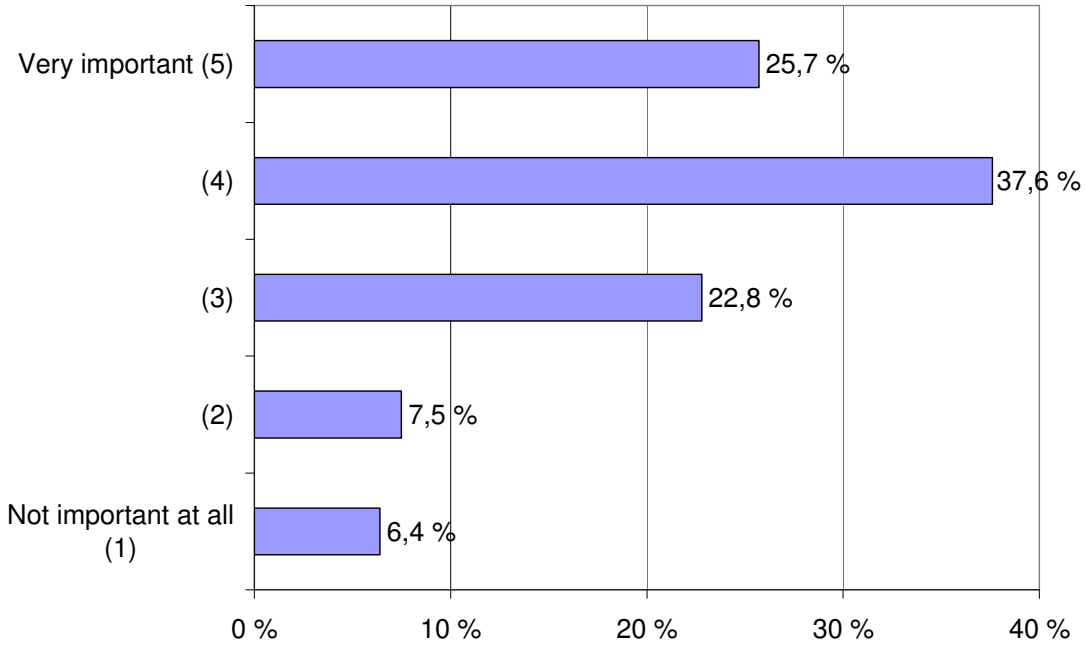

Figure 4. Importance to improve the possibilities to monitor energy consumption at home (N=3008, mean: 3.7).

PROTOTYPE

The results of the interview survey show that it is important to improve the possibilities to monitor energy consumption. A new prototype for monitoring energy consumption was developed in this work. The prototype gives occupants real time feedback on their energy consumption and the costs. In addition to the total consumption and costs, the prototype is able to present electricity consumption and costs of each device. The target is to create a system that gives occupants relevant information in a way that is easy to understand. Main components of the prototype are presented in Fig. 5 and the user interface of the prototype is presented in Fig. 6.

In the prototype two LonWorks technology based electricity meters were connected to a computer that works as a home server. The measured values were true RMS power, reactive power, power factor, true RMS energy, reactive energy, AC frequency, peak demand and computed values of RMS voltage and current. These values were saved in a database (home service book) once a minute.

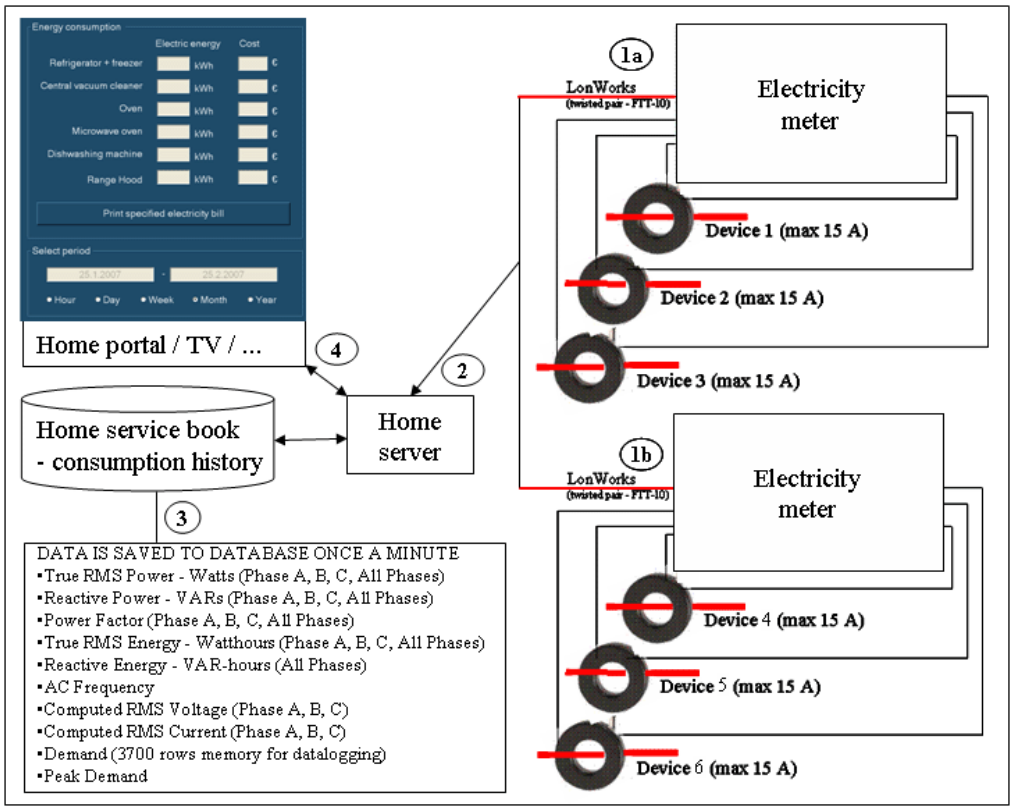

Figure 5. Main components of the prototype for monitoring energy consumption at home.

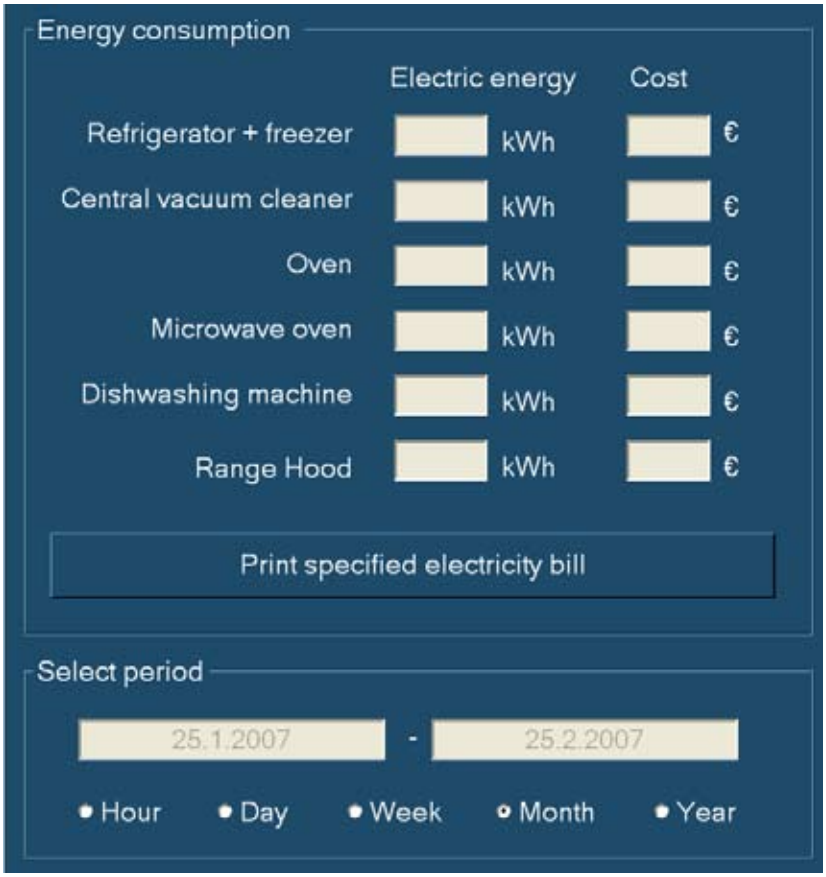

Figure 6. User interface of the prototype for monitoring energy consumption at home.

The user interface in Fig. 6 presents electricity consumptions of kitchen equipment and vacuum cleaner. Depending on the case, it would be very valuable to include also lighting, heating and air conditioning etc.

The prototype system is installed in two houses in Finland, in VTT's experimental low energy house Metop in Espoo and in Work Efficiency Institute's (TTS) experimental house in Nurmijärvi. A study of usefulness of the prototype was performed in Work Efficiency Institute's experimental house with twelve test persons. The participants were between 29 and 84 years old. The test persons think that electricity monitoring system is necessary in future, for example, in the case of selling the house. The user interface of the prototype was found to be clear, and it was easy to monitor electricity consumptions of domestic appliances. The test persons believe that this could affect their use of electricity. A forthcoming publication will present the results of the tests in more detail.

Next the consumption monitoring system will be improved with several new features. The main improvement concerns non-intrusive appliance load monitoring (NIALM) [2-5].

DISCUSSION

Public discussion on climate change and global warming has been very active in Finland in this year and in the end of the previous year. The interviews were performed before that. It is probable that people are currently even more interested in saving energy and monitoring energy consumption.

A review [6] of intervention studies shows that giving people information does not necessarily lead to behavioural changes or energy saving. Instead, according to the review, feedback appears to be an effective strategy for reducing energy consumption. The more frequent the feedback is, the more effective it is. For example, continuous display of electricity consumption was associated with an average saving of 12% in USA [7]. In another study [8], the effects of daily and monthly feedback on gas consumption were compared. It was found that those who received monthly feedback saved less that those who received daily feedback (7.7% vs. 12.3%).

The prototype developed in this work targets energy saving by means of feedback, i.e. by continuously informing how much energy each device consumes and what does that cost. There is clearly a potential to save energy with the system. In this phase, not enough evidence is, however, available, because the system is not installed to any real household yet.

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