

Influence of end-users' behaviour on energy consumption patterns in the Hungarian domestic sector: results of the REMODECE project

Benigna Boza-Kiss*, Anne-Claire Loftus*, Aleksandra Novikova*, Victoria Novikova*, Maria Sharmina, Diana Ūrge-Vorsatz***

*Central European University, Center for Climate Change and Sustainable Energy Policy

**Central European University, Economics Department

Abstract

The Hungarian residential sector is the largest energy consumer in the country and is responsible for more than a half of heat and a third of electricity consumption. For this reason, the residential sector could be a significant contributor to energy saving and greenhouse gas mitigation targets in Hungary. According to the authors' investigation, there has been no in-depth research aimed at obtaining high-quality data on penetration of appliances, their technical characteristics (type, age, efficiency level, etc.) as well as end-use behavioral patterns that altogether determine the residential energy consumption in Hungary. To address this gap in knowledge, a research team at Central European University (CEU) analyzed end-use behavioral patterns of the residential energy consumption in Hungary in the framework of the European project called REMODECE (Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe). In order to trace the energy consumption habits of the Hungarian population, a survey of 500 households was conducted. The households selected for the survey constitute a representative, highly consistent sample, although a focus on Budapest was placed.

The main findings of the study include identification of trends towards increased penetration of new appliances such as dishwashers and tumble dryers, which are still uncommon for a typical Hungarian household, and improvement in the energy efficiency levels of the new appliance stock. In addition, the paper details on user behavior patterns in relation to domestic appliances and lighting as well as on the respondents' awareness about Energy Star and energy labeling, in general.

Introduction

The Hungarian residential sector is the largest energy consumer in the country. It is responsible for more than a half of district heat and a third of electricity consumption [1]. For this reason, the residential sector could be a significant contributor to energy saving and greenhouse gas abatement targets in Hungary. For evidence-based design of energy conservation policies, it is important to identify the residential energy consumption structure and understand the driving forces behind its dynamics. According to the authors' investigation, there has been no in-depth research aimed at obtaining high-quality data on penetration of appliances, their technical characteristics such as type, age, energy efficiency level, etc.) as well as behavioral patterns that altogether shape the residential consumption in Hungary.

To address this gap in knowledge, a research team at Central European University (CEU) analyzed end-use behavioral patterns of the residential energy consumption in Hungary in the framework of the REMODECE project (Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe), which was financially supported by the European Commission's Intelligent Energy Europe Programme and co-financed by the Central European University Foundation in Hungary. In order to trace the energy consumption habits of the Hungarian population, a survey of 500 households was conducted.

The paper presents the main results of the part of the project related to the household survey. The structure of the paper is as follows. Following the introduction, the methodological section details the methodology applied during the survey phase of the project as well as gives a general description of the question-and-answer form used. The next section elaborates on the key results of the implemented project and draws some conclusions regarding the Hungarian household energy consumption patterns, appliances' ownership rates, age and their efficiency levels. The final section provides an overview of the results and a discussion of possible implications for energy consumption.

Methodology

Selection of the participants was random for 400 questionnaires that were gathered by the market survey company. For them, quota-based sampling was used, in a way representative of Hungarian averages (the variables are: size of town, sex and age). The sample was selected from a publicly available database for face-to-face interviews. Another 100 questionnaires were given to the existing sample of households whose end-use electricity consumption had been measured within the framework of the REMODECE project. The representativeness of this sample is discussed below. Convenience sampling based on personal contacts and contacts of contacts was used as a first approach to collect the 400 questionnaires apart from the 100 ones coming from the metered households. Contacts from other Hungarian environmental organizations, in particular those participating in the KOTHALO¹ were used, in addition to the

¹ <http://www.kothalo.hu/>

questionnaire being distributed within the CEU Hungarian community itself and acquaintances of the CEU team. This approach however proved to be rather unsuccessful, with only approximately 5 completed questionnaires received. For the purposes of obtaining the filled-in questionnaires, neither telephone nor web-based methods of survey were used.

Analysis of the data and main results

Cold appliances

Ownership rates

The ownership rate for refrigerators with freezers (two-door) is 24.7%, while that for refrigerators without integrated freezers (one-door) is 81%. Overall ownership of refrigerators in this sample is of 105.7%, which compares with the national average of 108% given by the Hungarian Statistical Office [2] in 2004. Interestingly, the split of two-door and one-door refrigerators given by KSH is 36% and 72%, which may either be due to differences in sample size between the two surveys or to an actual replacement of two-door fridges by one-door fridges, perhaps due to the increase in average dwelling size which affords more space for the storage of two cold appliances.

Age

The hypothesis of the refrigerator stock increasingly shifting to refrigerators without freezers is supported by Figure 1 and Figure 2 below, which show the stock of two-door refrigerators has an even age distribution, while more than half of the refrigerators without freezers are under 5 years old.

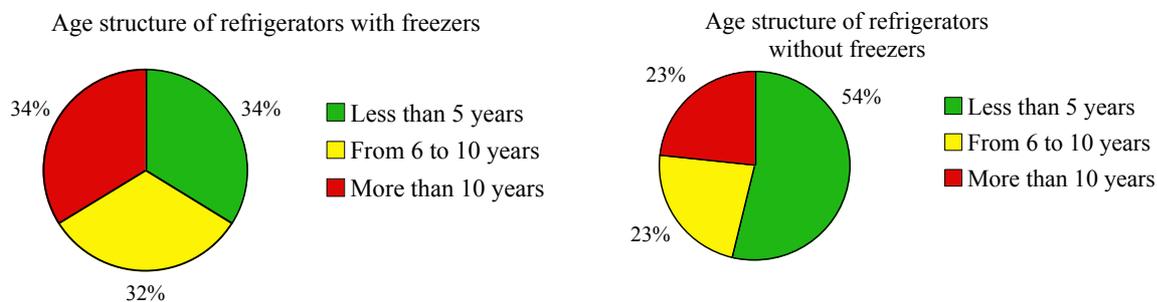


Figure 1 and Figure 2. Age structure of refrigerators with and without freezers

Volume

The relationship between an appliance age and volume is of most interest to researchers (see Figure 3). Two trends emerge: first, the average volume of both one and two-door refrigerators is much higher for appliances under five years of age; this may be due to increasing penetration of large American-style refrigerators. Second, while older one-door refrigerators had a larger average volume than that of two-door refrigerators, for appliances under five years of age the average volume is approximately equal.

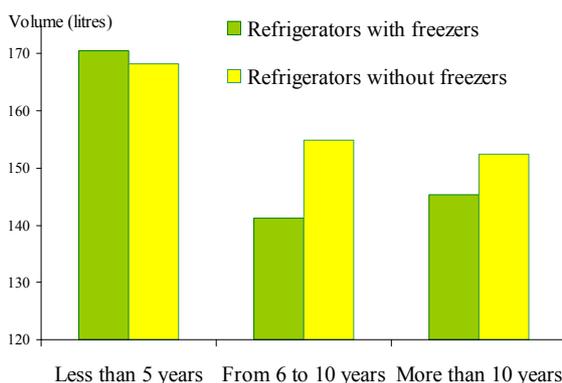


Figure 3. The correlation between the age and volume of cold appliances with and without freezer compartment

Washing machines

Ownership rates

The ownership rate for washing machines of 96.2% is higher than the national average of 83% given by the Hungarian Statistical Office [3]. This discrepancy may be due to the Budapest weighting of the survey, as ownership of white goods is likely to be higher in the richer and more educated capital city.

Age

The age of the most washing machines in Hungarian households ranges from 6 to 10 years old (see Figure 4).

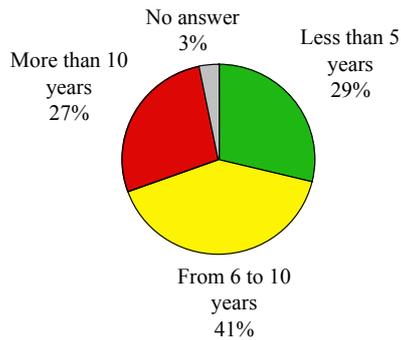


Figure 4. Age structure of washing machines

Capacity

Smaller washing machines predominate (see Table 1); this may be due to the Budapest weighting of the survey, as smaller apartments dominate in the capital city. Perhaps the split would have been different in a truly representative survey, as 2/3 of the country is composed of single family homes, which may have more room for larger machines.

Table 1. Capacity of washing machines and their share in the total number of washing machines owned by households

Capacity	%
5 kg or less	62.5
More than 5 kg	28.0
No answer	9.5

Cooking appliances

The majority (71.6%) of respondents claim to always use a lid when using a pan to cook, but the use of pressure cookers, where a fixed lid allows for much more rapid cooking time and hence reduced energy consumption, is limited (almost 60% of respondents never use one). See Figure 5 and Figure 6 for the graphical representation of the results.

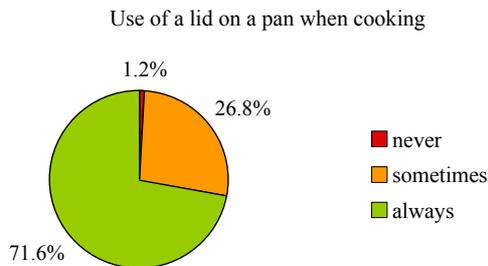


Figure 5. Use of a lid on a pan when cooking

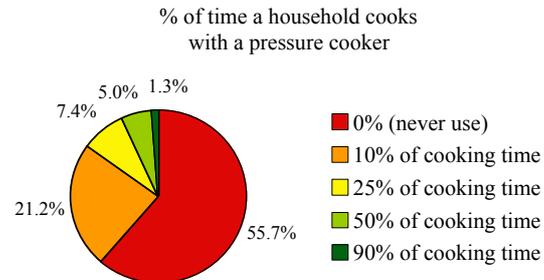


Figure 6. Share of time households cook with a pressure cooker

The REMODECE questionnaire included some questions regarding cooking behavior, for example asking whether or not respondents use a lid while cooking. The project team added a question which seeks to determine the number of hours spent for cooking per week, as this provides a valuable insight into household energy use. As it can be seen from Figure 7, roughly equal percentages of households (around 20%) cook very seldom (under 3 hours per week) and very often (from 7 to 10 hours and over 10 hours per week). The majority (40%) spend between 3 and 7 hours cooking per week, which, if averaged out to 5 hours, translates to 40 minutes spent cooking each of 7 evening meals.

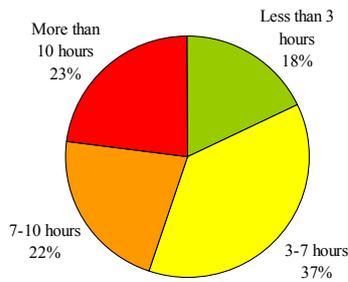


Figure 7. Number of cooking hours per week per household

Office appliances

Ownership rates and user behavior in relation to office appliances

Table 2 shows that the ownership rate for desktops and monitors is the highest for office equipment (around 60%), while that of fax machines, scanners and copiers is low (around 20%), probably because these are not considered to be basic equipment for household use. As for the behavior of users of this equipment, it varies from appliance to appliance, as can be seen in the chart below. While desktops, monitors, printers, laptops and speakers are mostly turned off, stand-by is mostly limited to appliances such as monitors, modems and routers, which are perhaps more easily forgotten. Routers and modems are also the appliances most frequently left on all the time.

Table 2. Ownership rates and user behaviour of the office appliances (percentage share of the total use)

	Ownership rate, %	Mode, %			We unplug it or switch off the strip, %	No answer, %
		turned off	stand-by	turned-on		
Desktop	60.5	59.7	11.8	2.3	18.7	7.5
Monitor	60.1	49.2	21.5	3.6	17.8	7.9
Speakers	45.4	52.4	9.6	5.7	14.4	17.9
Printer	41.9	52.1	6.2	1.9	15.6	24.2
Laptop	34.3	42.2	6.9	1.7	23.1	26.0
Modem	31	12.8	12.8	28.2	10.9	35.3
Router/hub	26.6	9.0	16.4	19.4	6.0	49.3
Scanner	25.4	15.6	4.7	0.8	13.3	65.6
Copier	22.8	11.3	0.0	0.0	7.8	80.9
Fax	22	7.2	5.4	8.1	4.5	74.8

Awareness and usage of Energy Star label

Consumer education should focus on making users aware of the real power saving options available to them. The Energy Star label is one of the solutions as it makes power saving modes the default option on labeled computers. Figure 8 and Figure 9 give more information on Energy Star awareness and usage in Hungary. Forty percent of respondents do not know what the label refers to, while 35% of respondents have correctly identified its purpose. As for the choice of Energy Star equipment in the purchasing of home office equipment, only 30% of respondents always choose labeled equipment, while 20% has never bought such equipment. Both of these questions illustrate the need for better education and promotion of the label, both at the retailer and consumer level.

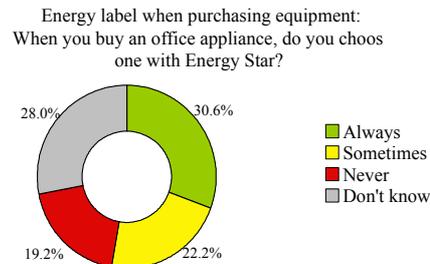
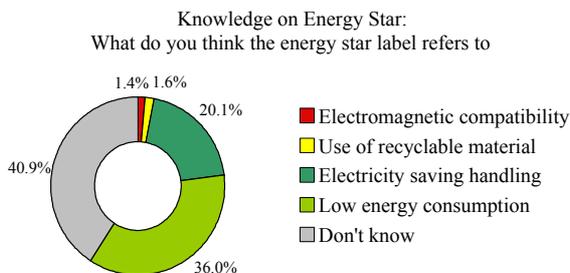


Figure 8. Energy efficiency labels awareness: What does Energy Star refer to? **Figure 9. Intensity of Energy Star usage in Hungary**

Home entertainment

Figure 10 demonstrates the modes which are applied to entertainment equipment when it is not in use. As expected, a significant share of equipment such as set top boxes is left on permanently, televisions are put in stand-by mode² most often, and more seldom-used equipment such as DVD players or Hi-Fis are turned off with the on/off button and thus left in soft-off mode³.

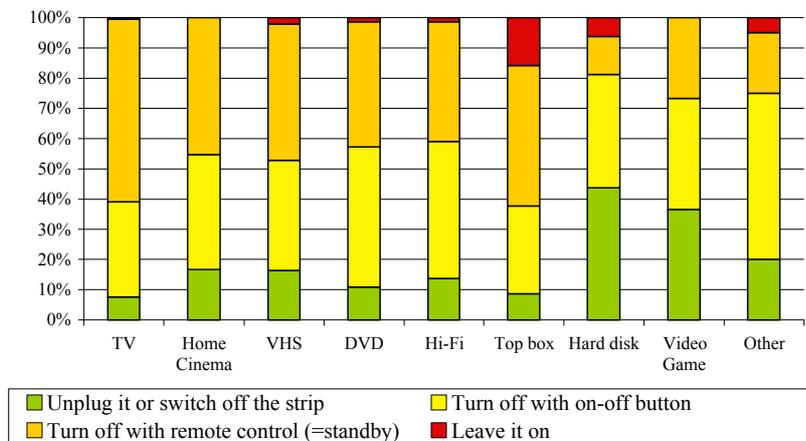


Figure 10. Entertainment equipment modes when idle

Over 70% of respondents claim to be aware that some appliances use electricity when they are in stand-by or soft-off mode, and only 23% are not aware of this fact. Unfortunately, this apparent awareness of the standby phenomenon is not necessarily translated into action, as it was discovered with relatively high share of equipment left in standby (for example, 60% of television sets). Consumer education is obviously needed in the home entertainment sphere, both by providing information (for example separating a fact from myth regarding screen savers) as well as technical advice: for example, under 55% of households use a multiple socket plug with switch in order to disconnect with ease all appliances from the mains.

Lighting

Figure 11 illustrates the different types of lamps that can be found in Hungarian households. The largest number of bulbs overall can be found in living rooms, followed by bedrooms and kitchens. Incandescent light bulbs are present in a higher proportion than other types of lamps in most rooms other than kitchens and WCs. Fluorescent lamps can be found in kitchens, bathrooms, outdoors and in other rooms; high wattage halogen lamps are mostly present in kitchens and bathrooms, while low wattage halogens are mostly found in kitchens and combined use rooms. As to compact fluorescent lamps (CFL), their penetration is the highest in WCs, but they also compose over 20% of lighting in living rooms, bedrooms, kitchens, hallways and other rooms.

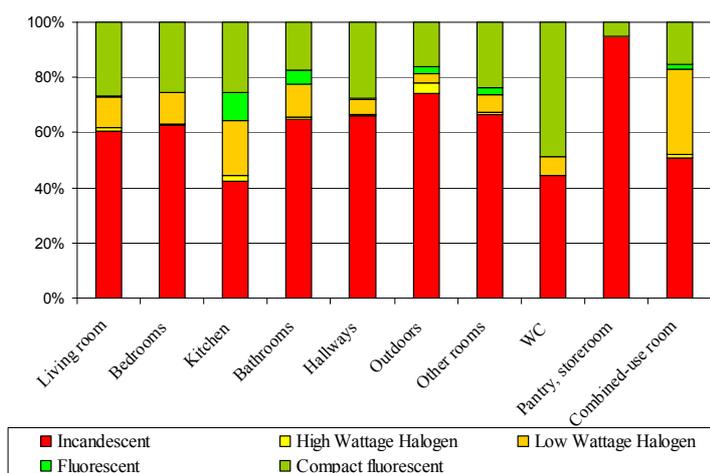


Figure 11. The allocation of light bulb types of in different rooms

² Standby mode is referred as the mode in which a device is carrying out at least one function, but not the main one, and is waiting for a task [4].

³ Soft-off mode is referred as the mode in which a device is not carrying out any function, appeared to be switched off, but is plugged in the mains and is still consuming energy [4].

Conclusion

The paper details results of the survey conducted in Hungary in the framework of the REMODECE project. It investigates the present status of energy use habits in the set of studied households. The households selected for the survey produce a representative, highly consistent sample.

The main findings of the projects include identified trends in new appliance ownership, especially increasing ownership levels of appliances that are currently less commonly used in Hungarian households such as dishwashers and tumble dryers, as well as improvement in the energy efficiency of the new appliance stock. The age structure of the equipment stock does not indicate that there is a shift towards newer appliances of different kinds. For example, there is clear dominance of newer refrigerators, which might be attributed to their energy saving characteristics. However, the picture is not so explicit with regard to washing machines where the age ranges from 6 to 10 years old (unlike “under 5 years” dominance in the case of refrigerators).

The findings in relation to energy efficient behavior in the kitchen are not very straightforward. For instance, more than 70% of the households always cover pans with a lid during cooking; on the other hand, more than 55% of the families do not use a pressure cooker.

According to the project’s results, the Hungarian households are more aware of the energy class of newer equipment. Another finding on the cooking behavior is that roughly equal percentages of households (around 20%) cook very seldom (under 3 hours per week) and very often (from 7 to 10 hours and over 10 hours per week) while the majority (40%) spend between 3 and 7 hours cooking per week.

Regarding the households’ awareness of energy labelling, about 55% of the residents know what it aims at with the rest of the respondents not aware of its purpose. At the same time, slightly more than 30% of the households always look for the energy star when they buy appliances; about 22% do it only sometimes during their shopping.

Although, nowadays, households buy more efficient electronic equipment, including liquid crystal display (LCD) monitors as well as long fluorescent and compact fluorescent lamps. However, regardless this shift towards more efficient lighting, office equipment and household electric equipment, electric residential end-uses are characterized by the increased energy consumption due to the higher ownership rate of information and communication technology (ICT) equipment and different kinds of entertainment appliances, as well as additional comfort elements, such as air conditioners. These findings are consistent with the rise in the standard of living apparent in the new EU member states such as Hungary [5].

References

- [1] International Energy Agency (IEA). World Energy Outlook 2007. Paris: OECD/IEA.
- [2] Házirtás-statisztikai Évkönyv (KSH). Household Statistics Yearbook 2005. Budapest: KSH. [On-line] URL: www.ksh.hu.
- [3] Házirtás-statisztikai Évkönyv (KSH). Household Statistics Yearbook 2006. Budapest: KSH. [On-line] URL: www.ksh.hu.
- [4] Schloman, B., Cremer, C., Friedewald, M., Georgieff, P., Gruber, E., Corradini, R., Kraus, D., Arndt, U., Mauch, W., Schaefer, H., Schulte, M., and Schroder, R. 2005. Technical and legal application possibilities of the compulsory labelling of the standby consumption of electrical household and office appliances. Project No. 53/03. Federal Ministry of Economics and Labour.
- [5] DeAlmeida A. and Fonseca P. 2007. Residential Monitoring to Decrease Energy Use and Carbon Emissions in Europe. [On-line] URL: http://www.isr.uc.pt/~remodece/news/Paper_DeAlmeida.pdf