Standing By in Central Europe: A Survey of Hungarian, Romanian and Bulgarian Residences

Diana Ürge-Vorsatz, Central European University, Hungary
Kristina Sroukanska, Regional Environmental Center, Bulgaria
Szilárd Asztalos, University of Sheffield, United Kingdom

ABSTRACT

In recent years, several developed countries have launched a concerted effort towards reducing standby electricity losses in household appliances and information technology (IT) equipment. Unnecessarily consumed electricity poses a special burden for the residents of Central and Eastern European (CEE) countries. Electricity prices have risen drastically during the past decade in these countries, with incomes stagnating or losing their value, thus paying utility bills has become a major problem for a wide group of consumers. In addition, the old and often obsolete appliance stocks in these countries are in dynamic turnover. Thus, early policy action to reduce standby consumption of newly purchased appliances in these times of dynamic market changes can have a major long-term impact.

However, to the knowledge of the authors, no comprehensive studies have been conducted exploring the extent of the problem in CEE yet. A team at the Central European University (CEU) has attempted to establish the baseline for standby electricity consumption in the region. The research included measurement of appliances and IT equipment in 99 households in 3 countries – Hungary, Romania and Bulgaria –, and interviews about residents' awareness of the standby problem and possible mitigation measures. The results of the measurements have been used to develop national indicators related to standby losses for these countries. Our findings show that the current figures used internationally (e.g., by the IEA) are underestimates. The interviews show that there is a very limited awareness of the problem and possible solutions among consumers, while most of them would be willing to modify their behaviour in order to cut electricity bills.

Introduction

Recent studies (Rainer *et al.* 1996; Siderius 1999; Lebot *et al.* 2000; Ross and Meier 2000) brought to attention the issue of reducing the standby electricity losses of household appliances as an option to mitigate CO_2 emissions in the residential sector. The results of research conducted by researchers around the globe showed that a significant amount (5%-26%) of household annual electricity use is "lost" by electricity consumption for secondary services that we do not need and are not aware of (Ross and Meier 2000; Lebot *et al.* 2000; Rainer *et al.* 1996; Meier *et al.* 1992; Siderius 1999; Nakagami *et al*. 1999). Since the variety of electric appliances and their penetrations are rapidly growing worldwide, and most of these have in-built standby features, the problem is expected to escalate in the near future, unless global measures are taken.

In order to consider the cost-effectiveness of measures aimed at reducing standby losses, it is necessary to understand the scale of the issue in various countries. A large

number of studies have been conducted on standby power consumption in Western Europe, The United States, Japan and New Zealand (Lebot *et al.* 2000). However, in most cases these studies are not nationally representative or the methods used are not compatible with each other. At present, to our best knowledge, the subject remains largely unexplored in Central and Eastern Europe (CEE).

The issue of standby electricity consumption has a special importance today in the CEE region. During the communist era, the consumption of the "luxury" goods of consumer societies was constrained by the governments. As a result of limited imports and local manufacturing concentrating on basic appliances (such as refrigerators and washing machines), the penetration levels of "luxury" devices (microwave ovens, dishwashers, etc.) were below levels offered by the affluence of the population. Therefore, the fall of communism at the turn of the 90s found a major market in CEE "hungry" for Western-style luxury goods, including convenience household appliances.

Today, the saturation levels of household appliances have increased, but they are still far from full saturation. While the economic recession of the mid-90s (some economies have shrunk by as much as 60%) has not left much dispensable cash in family pockets, the economic recovery at the turn of the millennium has been pushing up the demand for white goods.

Dynamic market changes always provide excellent opportunities for the introduction of energy-efficiency policies. Today, there is a significant window of opportunity in the CEE region for creating some of the most sustainable appliance stocks in the world. If fast action is taken, the dynamic increase in appliance saturations expected in the near future will be satisfied by energy-efficient models. In addition, households using products manufactured during the socialist era are also often eager to replace their goods by more fashionable "Western" style varieties; thus we can expect market turnover in such appliances before the end of their lifetimes. As a result of an appliance stock whose characteristics will be largely influenced by the product offerings of the near future, the early introduction of progressive standby-related policies can make a disproportionate difference in these economies in transition.

Aims and Objectives

The aim of this paper, therefore, is to provide an understanding of the scale of the residential standby energy problem in Central Europe (CE). This paper reports the results of a research project conducted by the authors of this paper at the Central European University. The purpose of the research was to assess the magnitude of residential standby electricity consumption in three selected CE countries: Bulgaria, Romania and Hungary. The objectives of the research were:

- To measure the standby power consumption of appliances in a sample of typical households in Bulgaria, Romania and Hungary;
- Collect information related to "leaking" appliances (ownership, usage, consumption patterns)
- To estimate standby electricity consumption at the appliance, household and national levels
- To estimate related CO_2 emissions;

- To estimate potential national electricity and emission savings as a result of the introduction of progressive standby policies.

Methodology

The sections below describe the key elements of these methods in detail. Assumptions made are discussed in the relevant sections of this paper.

Study Design

The literature documenting standby power related research (Olof 1997, Meier 1997, Evans 1997, Nakagami 1997, Meier and Huber 1999, Ross and Meier 2000, Sidler 1999, Anglade *et al.* 1999, Lebot *et al.* 2000, Harrington 2000) identifies two key methods used for estimating the standby power consumption in individual countries. These are field studies or whole-house measurements, and "bottom-up" estimates. The main method applied in the present study is household field measurement in selected CEE countries. This method was chosen due to the lack of statistical data on the stock of electric appliances in Bulgaria and Romania and in order to make meaningful comparison of the three countries. Thirty households were measured each in Romania and Bulgaria, and 39 in Hungary. The sample households were selected from different income levels and residential areas of cities. All the measured homes were in blocks of flats. The bottom-up approach was partially applied in the Hungarian standby assessment, because data were found only for limited number of appliances. Bottom-up estimates were used for monitoring the bias of the results.

The consumption of appliances having standby consumption was measured in all the possible operational modes using the device EKM 265. After plugging the appliances into the measuring device, the display was read after three minutes, to allow the displayed consumption value to stabilize. Following this, household owners were asked to provide information regarding the average time an appliance spent in each operating mode (standby, on, unplugged). The results were then statistically processed, and country level estimates were made based on them.

The results of the survey were used to estimate the average standby electricity consumption per household for each country and for the region in general. National figures were derived using official household statistics from the corresponding national statistics offices. Carbon-dioxide (CO_2) emission figures were derived from IEA (2000b) and Thomas et al. (2000). The national level results, however, should be considered as first level estimates. Since the size of the sample is limited and there are no national statistics that can be used to crosscheck the results, the results should be used with these limitations in mind.

Measuring Protocol

Standby power in Watts was measured with Watt-meter model EKM 265 (accuracy 1.5%, range 1.5-2650W) according to the procedure applied in the most recent standby studies (Ross and Meier 2000; Nakagami *et al.* 1999; Anglade *et al.* 1999).

For the purposes of this study standby power was defined based on Ross and Meier (2000), as the minimum power consumed by the appliance while connected to the power

mains. The appliances were measured in off, idle and standby modes according to the particular device. All these modes are referred to in this paper as standby power. During the metering, the appliances were plugged into the mains and the meter and switched from the off button. Then, the appliance was switched into standby mode, and the standby consumption measured. Afterwards, the device was turned on and the "on" mode consumption was also measured. Finally, the appliance owner was asked how much time on average an appliance spends in all the possible modes. Computers and monitors were measured in off mode or the mode that the owner usually uses (standby, screensaver, suspend). Cordless phone chargers were measured while fully charged.

Results

The results of the field measurements and their analysis are divided into four sections, each one presenting a certain aspect of standby power consumption in the studied countries: appliance statistics, household statistics, national level estimates and potential savings in the case of implementation of the 1 Watt standby reduction plan.

Appliance Statistics

This section deals with the standby consumption of the different appliance types in the three studied countries. Table 1 presents the average daily standby power consumption of each appliance type, and the average number of appliances of each type in the studied households. Overall, 406 appliances were measured in the 99 surveyed households. In the three countries the most frequent appliances are TV sets, VCRs and Hi-fi stereos. In Romanian and Hungarian households these are also the appliances with highest average standby consumption per day. In Bulgaria satellite receivers, personal computers[1] (PCs), and combined phones and answering machines are the devices with the highest standby power values. These results are summarized in Table 2, which presents the average standby consumption values for the three countries.

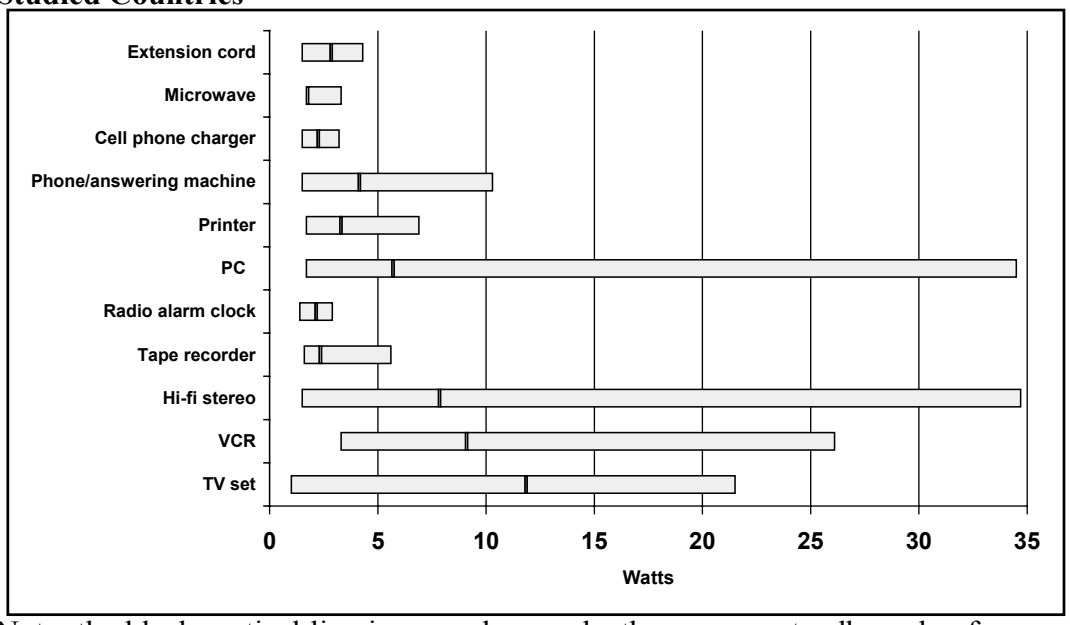
The minimum and maximum of the measured actual (not weighted by usage) standby power values of the appliances are presented in Figure 2. The lowest measured standby power is for TVs - 0W[2] -, and the highest is for PCs and Hi-fi stereos - 35W.TVs, VCRs, Hi-fi stereos and PCs have the widest standby power ranges in the three countries: the gap between minimum and maximum for Hi-fi stereos and PCs is the largest in Bulgarian sample. In Romania, the minimum standby power for TVs is0W, because some of the measured appliances did not have a standby feature (no remote control). Please note that for the calculation of the average standby value of TVs in Romania, only the non-zero values were taken into account, in order to show the average standby losses of those appliances that consume power in standby mode.

[1] Personal computers were measured as integral units, i.e. including all components (monitors, main body, modem, etc.). Printers were not included.
[2] For TV sets without a standby feature

Table 1. Appliance Standby Power Consumption in CEE, Based on 99 Surveyed Households in Bulgaria, Hungary, and Romania

Category	Appliance[3]	Number of appliances measured	Average number of appliances per household	Average standby consumption (Wh/d)
Video	TV	123	1.24	164
	VCR	55	0.56	217
Audio	Hi-fi stereo	43	0.43	191
	Tape recorder	15	0.16	51
	Radio alarm clock	23	0.23	47
Information Technology (IT)	Personal Computer (PC)	38	0.38	147
	Printer	9	0.09	59
Communication	Phone/answering machine	34	0.34	83
	Cell phone charger	14	0.14	37
Miscellaneous	Microwave	13	0.13	38
	Extension cord	15	0.15	53
	Total	**382**		

Figure 1. Standby Power Ranges of Different Appliance Types in the Three Studied Countries



Note: the black vertical line in every bar marks the average standby value for the given appliance type

[3] Only appliances found in more than one country are included.

Household Statistics

This section presents standby-related household statistics based on the measurements. Using the data gathered by measurements in individual households, average values were calculated. These average household statistics are summarized below in Table 2.

The standby power consumption per household is weighted by the time in which the appliance is usually in standby mode. The average standby power consumption per household is relatively close in the Bulgarian sample (33W) and the Hungarian sample (30W). In the Romanian sample, the standby power consumption per household is less than half (14W). While the study is not statistically significant enough to provide an explanation for this, the following reasons may be considered as an explanation for this difference, beyond the general differences in the levels of economic affluence. (1) On average in Hungary there are approximately twice as many computers per household as in Romania (0.6 compared to 0.3) and computers in general have high standby consumption. (2) The situation is similar for Hi-fi equipment. (3) In Hungary households have several small appliances that were not included in any specific category, but that as a whole (treated as Other) consume an amount that is not negligible. (4) In Hungary TVs typically have a remote control, whereas in Romania this is not always the case.

The average number of appliances with standby power consumption is between 3 and 5 for the three countries.

Table 2. Comparative Standby Household Statistics

Country	Average number of appliances with standby power per HH	Average standby power per HH (W)	Average standby consumption per HH (Wh/d)
Bulgaria	5.6	33	789
Romania	3.2	14	340
Hungary	3.7	30	709
AVERAGE	**4.2**	**26**	**613**

Discussion: Present State of Standby Power Consumption in Bulgaria, Romania and Hungary

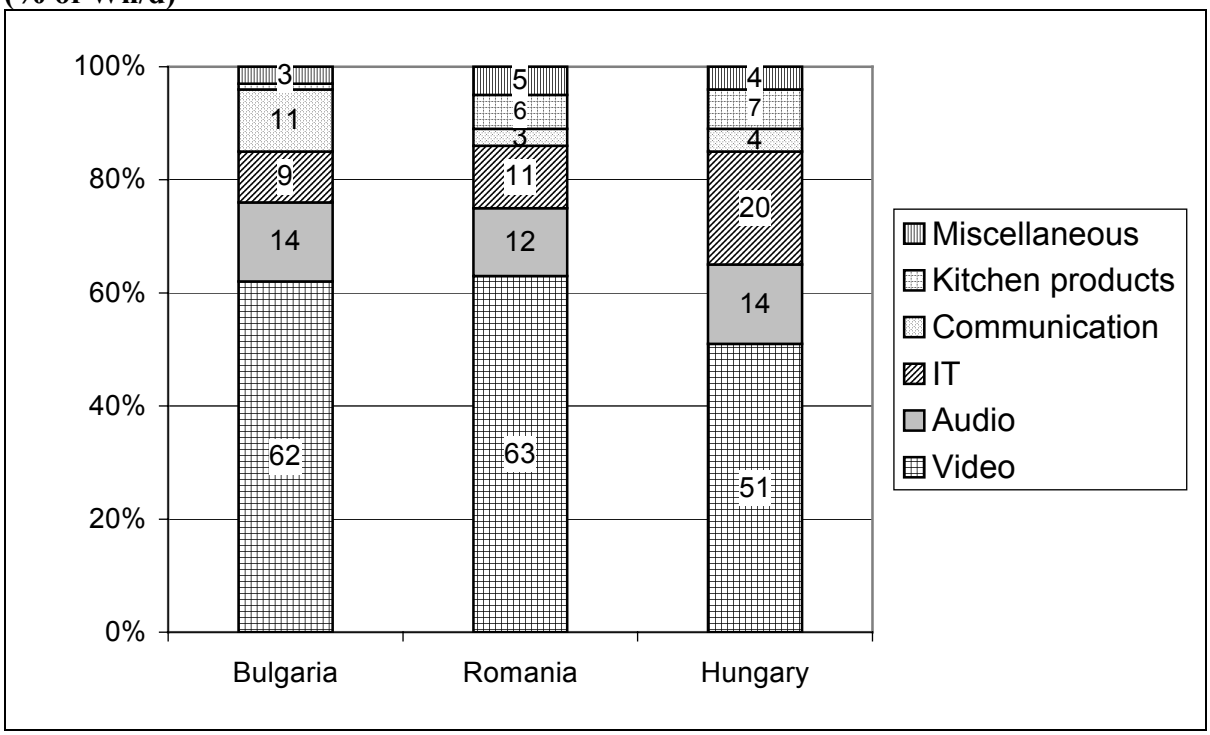
Appliances with Standby Features in Bulgaria, Romania and Hungary

The results of the analysis of the field measurements in Bulgarian, Hungarian and Romanian households demonstrate that the major 'leaking' appliances in the countries are TVs, VCRs, Hi-fi stereos, PCs, phones and answering machines. The exception to this is Bulgaria, where 4 satellite receivers were measured and were calculated to have the largest standby power consumption of all appliances in the Bulgarian sample. Figure 2 represents the shares (in %) of each appliance category in the total appliance standby consumption. Not surprisingly, the Video category contributes more than half of appliance standby power use:

it is very similar for Bulgarian and Romanian devices (respectively 62% and 63%) and slightly less in Hungarian ones (52%). The Audiovisual and IT categories add up to nearly 90% of the total standby consumption: in Hungarian appliances the share of the IT category is significantly bigger than in the other two countries. Kitchen products do not contribute significantly to the total appliance standby consumption.

These results lead us to the conclusion that the most urgent and broadest measures should be targeted at Video and Audio equipment, since appliances from these categories, as shown above, are also the most proliferated in all three countries and have the broadest standby power ranges.

Figure 2. Contribution of Appliance Categories to Total Standby Power Consumption (% of Wh/d)



Another important fact is that when compared to data from highly developed OECD countries, the penetrations of different appliance types are low (Table 2)(IEA 2001, Rainer *et al.* 1996). In Australia, for example, penetration data for TVs, VCRs and PCs are the following: 1.90, 1.30 and 1.27 (Harrington and Kleverlaan 2001): compared to 1.30, 0.77, 0.60 in Bulgaria; 1.53, 0.40 and 0.30 in Romania; and 0.97, 0.51 and 0.51 in Hungary. In general the penetration of any appliance type is higher in OECD countries than in Romania or Hungary. This fact supports our hypothesis that market penetration of some white goods are currently below full saturation in the CEE region, and thus appliance ownership can be expected to grow in the future.

As a general trend, standby power consumption for a certain appliance type varied within a wide range, especially in the case of TVs, VCRs and Hi-fis. This fact demonstrates that standby power reduction can be achieved by changes in products, given that the appliances with higher standby power values did not perform any extra function.

Standby Power Consumption and Associated CO_2 Emissions in the Region

Table 3 summarizes the key national and household level estimates of standby electricity consumption related indicators derived in this research in comparison with international data. The values of standby power use per household in the three studied countries are lower than in other developed countries. Examples of the opposite can be found as well: for instance, a typical Swiss household dissipates 19W for standby purposes; while French and Dutch families consume about as much standby power as Hungarian and Bulgarian residences (30W and 33W, respectively) (IEA 2001).

The percentage of total residential electricity use in Bulgaria could not be calculated because it was not always possible to collect data on the total electricity consumption of the surveyed households. In Romania and Hungary the figures are in agreement with the official figures (KSH 2001).

Country level estimates show that the total national electricity consumption from standby power is nearly 1 TWh annually in each examined country. This figure corresponds to 2.0-3.0% of the total national electricity consumption. This estimate is higher than estimates for other countries presented by IEA (2000), such as the USA (1.3%) or Japan (1.7%).

As far as greenhouse gas (GHG) emissions are concerned, the three countries generate almost the same amount of CO_2 related to their residential standby consumption (0.4 Mt for Bulgaria and Hungary and 0.3 Mt for Romania).

Table 3. Estimated Energy Demand and CO_2 Emissions from Residential Standby Power in Bulgaria, Hungary and OECD Countries

Country	Number of HH (millions of units)	Average standby power (W/HH)	Annual standby Electr. Use (KWh/yr)	Fraction of total resid. Elec. Use (%)	Total standby power demand (MW)	Total standby energy (TWh/yr)	Standby as % of national electricity (%)	CO_2 from standby power (Mt)	Standby as % of national CO_2 (%)
Bulgaria	***2.96***	***33***	***288***	***N/a***	***98***	***0.85***	***2.6***	***0.4***	***0.8***
Romania	***7.4***	***14***	***154***	***7.3***	***104***	***0.96***	***2.0***	***0.3***	***0.3***
Hungary	***3.85***	***30***	***259***	***11.5***	***116***	***0.99***	***3.0***	***0.4***	***0.7***
Germany	36.03	44	389	10	1585	13.9	2.6	9.6	1.1
Australia	7.09	87	527	13	617	5.4	3.2	5.1	1.7
Japan	41.2	46	530	12	1,903	16.7	1.7	7.3	0.6
USA	101.4	50	440	5	5.052	44.3	1.3	28.7	0.5
OECD	386	38	332	N/a	14,634	128	1.5	68	0.6

Sources: Lebot et al. 2000, IEA 2000b, IEA 2001, BNSI 1992, KSH 2001, Thomas et al. 2000, and the authors' research results (in italic).

Comparison with Existing Estimates

Among the studied countries, the authors of this paper were only able to find standby power estimates for Hungary . The IEA (2001) suggests a 20W household standby figure for the Czech Republic, Poland and Hungary. Based on this estimate, the authors conclude that the level of standby power consumption in the CEE region is a larger problem than previously assumed, by as much as 50% (30W for Hungary and 33W for Bulgaria; see Table 2).

In conclusion, it can be stated that although in absolute values standby power consumption in Bulgaria, Romania and Hungary are below most of OECD values, its ratio to total consumption makes it important, especially for appliance owners, who have to pay at least 7 - 10% of their total electricity bill[4] for something they do not benefit from.

Potential Impact of Standby Reduction Measures

One of the suggested ways to reduce standby power consumption from households is to establish a cap for standby power losses of new appliances. In case of the fulfillment of the 1-Watt target outlined by Meier et al. (1998), standby power consumption would drop by 80-90% in the three studied countries. This equals to average of 0.8 TWh of electricity saved annually per country (see Table 4). This in turn would prevent around 0.3 millions of tons of CO_2 from being emitted into the atmosphere. Average standby power consumption per household would drop to below 5W.

Table 4. Estimated Standby Power Consumption after Implementation of the 1Watt Plan in the Studied Countries

Country	Total annual residential standby power (TWh/yr)	Average standby power per HH (W)	Average daily standby consumption per HH (Wh/d)	Total standby power saved (TWh/yr)	Total annual CO_2 emissions saved (Mt)
Bulgaria	0.13	5	120	0.72	0.30
Romania	0.16	2.3	56	0.8	0.24
Hungary	0.12	3.5	84	0.86	0.30

Recommendations

Based on the results of the study, the authors conclude that residential standby power consumption in Bulgaria, Romania and Hungary is significant enough to warrant the introduction of mitigation policies. Its 7-10% share of residential electricity use adds up to significant power consumption, especially if viewed for longer periods. This, on one hand, means an unnecessary expenditure for households and, on the other hand, it contributes to global carbon dioxide emissions. In addition, the suspension of electricity price subsidies in post-socialist countries has posed a major financial burden on the population. Therefore,

[4] These figures are underestimates. Because electric water heating and other major, not-time-specific end uses maybe driven by reduced-tariff night-time electricity rates, we estimate the contribution of standby losses to utility bills are significantly higher.

cutting standby-related expenditures of the families could address important social problems as well, by compensating for the recent increases in utility bills. Under these circumstances, the authors propose the these countries should urgently introduce measures curbing the standby electricity consumption of new appliances, such as those outlined by the IEA (2001) or by Bertoldi et al. 2000.

With regard to policy recommendations, however, an important issue needs to be raised. In the region of CEE, the majority of appliances is either imported, or locally produced by multinational corporations manufacturing for the world market. Therefore, in the absence of strong national policies among CEE countries, progress may still be achieved as a result of "free riding" on measures initiated by other countries. This means, that if the economies determining European appliance markets (such as the EU) adopt strong standby-related policies, the lion's share of CEE appliance markets will be transformed as well. However, this fact obviously should not relieve CEE governments from addressing the issue themselves.

Conclusion

There is an important window of opportunity for CEE economies in transition to influence the dynamic change of appliance stocks towards a more sustainable composition within the next few years. This opportunity is the result of vibrant market changes, an unsaturated market, and a relatively old appliance stock. Therefore, early action targeting residential standby electricity losses can make an important difference in this region.

The goal of this paper was to assess the magnitude of the residential standby consumption problem in the CEE region. To examine the issue, field measurements and tenant interviews were conducted in 99 households in Hungary, Bulgaria and Romania.

Our findings confirm that standby power consumption represents significant electricity loss in the studied countries. The study shows that the standby problem in this region is larger than estimated by the IEA. IEA (2001) assumed a 20W residential standby consumption for the most economically advanced CEE countries (Hungary, Czech Republic, Poland), while the present study identified 30 W for Hungary, 33 W for Bulgaria, and 14W for Romania. This corresponds to 7 – 11% of the average electricity bill of households in the region, and represents a considerable financial burden. An average Hungarian family spends as much as USD 21 annually for standby power; on a national level residential standby expenditures amount to USD 81 million. Due to still subsidized energy prices and a lower standby power consumption, the corresponding figures are lower for Romania (USD 5 per household, and USD 36 million for the country).

Only a few appliances account for the majority of standby losses, a fact explained by their significant individual standby power consumption, long daily standby time and high market penetration. Policies targeting just 4 devices, including key audiovisual equipment (TV, VCR and Stereo) and PCs, could address close to 90% of all domestic standby electricity use in the region. Early adoption policies targeting standby losses could also contribute to curbing GHG emissions in an important way: approximately 0.4 Mt of CO_2 could be saved in each of the studied countries annually.

Increasing social and economic burden of utility tariff hikes, poor environmental conditions caused by the energy sectors, and expected escalation of the problem of standby

consumption in the near future all warrant the urgent consideration of policies. However, this study only serves to indicate the size of the problem in the region. Further, more statistically representative research is needed to support cost-effectiveness considerations of any proposed measures.

Acknowledgements

The authors would like to express their gratitude to the following persons and institutions without whose help this study could not have taken place. First, Peter Karbo from the Danish Electricity Saving Trust has kindly donated three metering devices. Benoit Lebot from the International Energy Agency not only has been instrumental in obtaining the metering devices, but without his encouragement this work may not have been started. In addition, Alan Meier from the Lawrence Berkeley National Laboratory has provided invaluable advice and background materials. Finally, the Central European University has contributed a part of the costs of the field measurements.

References

Anglade, A., D. Beyrand, G. Burle and J. Roturier. 1999. "In-House measurements of the Electricity Consumption of Home Entertainment Appliances: The CEMEDA Collaboration." In *Proceedings of the First International Conference on Energy Efficiency in Household Appliances, 10-12 November 1997, Florence, Italy*, 332-341. Berlin: Springer.

Bertoldi, P., F. Conti and V. Berrutto. 2000. "The European Strategy for reducing Stand-By Losses in Consumer Electronics: Status and Results." In *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings. Information and Electronic Technologies*, 7.1-7.9. Washington D.C.: American Council for An Energy-Efficient Economy.

Evans, P. 1997. "Manufacturers success in reducing stand-by consumption of TVs and VCRs." Paper presented at the Workshop on Home Electronics, Conference on Energy Efficiency in Household Appliances, Florence, Italy, November1997.

Harrington, L. 2000. *Study of greenhouse gas emissions from Australian residential building sector to 2010*. Canberra: Prepared by Energy Efficiency Strategies, Inc. Cited in Lebot, B., Meier, A. and Piette, M. A. Global Implications of Standby power. In the *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings. Information and Electronic Technologies*.7.77 - 7.88. Washington D.C.: American Council for An Energy-Efficient Economy, 2000.

International Energy Agency (IEA). 2000a [on-line]. Task Force 1: Definition of Standby Power. http://www.iea.org/energy/ee.htm [cited 5 April 2001].

International Energy Agency (IEA). 2000b. *Key World Energy Statistics from the IEA*. Paris: IEA.

International Energy Agency (IEA). 2001. *Things That Go Blip at Night: Standby Power and How to Limit It*. Paris: OECD/IEA.

KSH 2001. Magyar Statisztikai Évkönyv 2000 (Hungarian Statistical Yearbook 2000). Budapest, Central Statistical Office, Hungary.

Lebot, B., A. Meier and M. A. Piette. 2000."Global Implications of Standby power." In *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings. Information and Electronic Technologies*, 7.77 – 7.88. Washington D.C.: American Council for An Energy-Efficient Economy.

Meier, A. 1997. "Results from the investigations on leaking electricity in the USA." Paper presented at the Workshop on Home Electronics, Conference on Energy Efficiency in Household Appliances, Florence, Italy, November 1997.

Meier, A. and W. Huber. 1999. "Results from the Investigations on Leaking Electricity in the USA." In *Proceedings of the First International Conference on Energy Efficiency in Household Appliances, 10-12 November 1997, Florence, Italy*, 342-352. Berlin: Springer.

Meier, A., W. Huber and K. Rosen. 1998. "Reducing Leaking Electricity to 1 Watt." Paper presented at the ACEEE Summer Study on Energy Efficiency in Buildings in Pacific Grove, CA., August 28.

Nakagami, H. 1997. "Stand-by electricity consumption in Japan." Paper presented at the Workshop on Home Electronics, Conference on Energy Efficiency in Household Appliances, Florence, Italy, November 1997.

Nakagami, H., A. Tanaka, C. Murakoshi and B. Litt. 1999. "Stand-by Electricity Consumption in Japanese Houses." In *Proceedings of the First International Conference on Energy Efficiency in Household Appliances, 10-12 November 1997, Florence, Italy*, 353-363. Berlin: Springer.

Olof, M. 1997. "Leaking electricity. a EU characterization study." Paper presented at the Workshop on Home Electronics, Conference on Energy Efficiency in Household Appliances, Florence, Italy, November 1997.

Rainer, L., S. Greenberg and A. Meier. 1996 [Date of Conference.] [on-line]. "You Won't Find These Leaks with a Blower Door: The Latest in "Leaking Electricity" in Homes." Paper presented at the ACEEE Summer Study on Energy Efficiency in Buildings, Asilomar, California, August 1996.

http://www.eetd.lbl.gov/EA/Buildings/LEAKING_ACEEE96/leaking.html [cited 3 April 2001].

Ross, J. P. and A. Meier. 2000. "Whole-House Measurements of Standby Power Consumption." In *Proceedings of the Second International Conference on Energy Efficiency in Household Appliances.* Naples (Italy): Association of Italian Energy Economics (Rome).

Siderius, H. 1999 [on-line]. "Standby Consumption in Households Delft". The Netherlands: Van Holsteijn en Kemna B.V. http://EETD.LBL.gov/Leaking/articles/Siderius.html [cited 5 April 2001].

Sidler, O. 1999. "End Use Measurement Campaigns of Electricity Specific Uses in the Residential Sector." In *Proceedings of the First International Conference on Energy Efficiency in Household Appliances, 10-12 November 1997, Florence, Italy*, 158-170. Berlin: Springer.

Thomas, C., T. Tennant and J. Rolls. 2000 [on-line]. *The GHG Indicator: UNEP guidelines for Calculating GHG Emissions for Businesses and Non-Commercial Organizations*. http://www.unepie.org/energy/activities/Efficiency/GHGindicator/GHGindicator.htm [cited 19 July 2001].