Energy savings potential from simple standby reduction devices in Central Eastern Europe

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Keywords

standby power, low power modes, energy behaviour, standby killer, energy saving potential

Abstract

The paper assesses the possible levels of electricity savings and economic benefits for consumers from using simple standby reduction devices in Central Eastern Europe, also taking into account the willingness of the users to change their behaviour.

Introduction

The total number of appliances consuming energy when not in use as well as the penetration rates of these appliances are growing steadily (EES 2006, EURECO Project 2002). Standby consumption represents 11% of the total electricity demand in European households, mostly concentrated in entertainment and office equipment (REMODECE 2008a[1]), meaning that an electricity bill of 1 month per year is paid for standby. Meanwhile, there have been both significant technological development and improved knowledge in this field in recent years, as well as a growth in political will. Yet, consumer awareness about the existence and the magnitude of standby powers, standby energy consumption and possible behavioural changes to curb these is still low (REMODECE 2008b, Fraunhofer IZM 2007).

Standby power levels of individual appliances are expected to decrease in the future due to technological change (Fraunhofer IZM 2007) resulting from a range of regulatory measures internationally and within Europe – mainly the regulation on standby and off mode (EC 2008) of the Ecodesign Directive (EC 2005). However, even until these measures are fully implemented (and later complementing them), users can contribute to the reduction of their energy consumption and therefore financial losses. Moreover, while energy consumption of standby and other low power modes at individual appliances are relatively small, the number of appliances drawing power when not performing their main function is constantly growing (Meier 2005).

The main goal of the study was thus to assess the attainable levels of electricity savings and economic benefits for consumers from using simple standby reduction devices. To determine this particular saving potential, the energy consumption of a newly equipped site was taken as a reference and compared to the same site equipped with various simple standby reduction devices. The national energy savings potential from the two main domestic appliance categories, which are the most significant in terms of standby (home entertainment and office equipment), was calculated taking into account the willingness of the users to change their habits and/or appliance set-up, by installing and using a standby reduction equipment in Central Eastern Europe.

1. The REMODECE project was carried out in 12 European countries. It evaluated the potential electricity savings that exist in the residential sector in Europe that can already be implemented by existing means. Further information on the project can be found at its official website http://www.isr.uc.pt/~remodece/.

Methodology

Data on standby power of household appliances was collected in the Czech Republic and Hungary[2] during a store metering survey commissioned in May 2008[3]. For every appliance metered in a retailer the power was measured while the appliance was in use (on), in standby (passive and/or active) and off mode, where applicable[4]. The data was collected using the metering equipment Voltcraft Energy Logger 3500.

In our study, two main appliance categories were analysed: home entertainment (television and its peripheral appliances) and office equipment (computer and peripherals). A home entertainment reference site was defined as a television (main appliance) with a DVD, a set top box and other appliances as "peripherals". An office site consisted of a desktop computer as the main appliance with monitor, printer, and speakers as "peripherals". The exact content of the reference sites was developed using the relative penetration rate for each peripheral equipment compared to the main appliance as found in real households in the reference countries (REMODECE 2008a). Similarly, the relative appearance of various technologies of the main appliance (such as CRT, LCD and plasma TV) was taken into account.

The savings potential at a reference site was defined as the difference between the total electricity consumption of a newly equipped site and one with the same equipment where the standby reduction devices are employed. While this reduction potential is lower than it would be when taking existing stock as a reference, the value is able to separate the savings from behavioural or usage change and technological improvement change. This method is also beneficial due to the much lower costs compared to a stock survey. The national electricity savings potential achievable through usage of simple standby reduction devices (switch socket power boards – a multiple socket power board with a manual switch or a more sophisticated standby killer[5]) was estimated using the following formula, separately for entertainment and office equipment:

$$P_S = N_{hh} \cdot \left(1 - P_{MS}\right) \cdot E_{site} \cdot P_{main}$$

Where $$E_{site} = E_{main} + \sum (E_{ap} \cdot P_{ap})$$

Where

P_S = potential savings (GWh/year)
N_{hh} = number of households in the country (CZSO 2008a, HCSO 2008)
P_{MS} = usage of multiple sockets with a switch in households (%) (REMODECE 2008a)
E_{site} = electricity saved/year per one site (kWh/year) (see calculation below)
P_{main} = penetration rate of the main appliances (televisions or desktops) (number of appliance per 100 households) (CZSO 2008a, CZSO 2008b, HCSO 2008
E_{ap} = average standby electricity consumption of one particular peripheral appliance from the site (kWh/year)
E_{main} = average standby electricity consumption of the main appliance of the site (television, desktops) (kWh/year)
P_{ap} = relative penetration rate of the particular peripheral appliance compared to the main appliance (REMODECE 2008a)

The yearly standby electricity consumption of one appliance (E_{main} in case of the main appliance and E_{ap} for the peripherals) is calculated using the weighted average of power levels of relevant modes according to the application of these modes for the given appliance (data from REMODECE project), multiplied by the number of hours per year in other than "on" mode (data from Fraunhofer IZM 2007). The total standby electricity consumption per site (E_{site}) is then calculated as the sum of the standby electricity consumption of the parts: the total yearly consumption of the main appliance added to the consumption of the peripherals possibly connected to the main equipment, which were weighted according to their relative penetration. Since there is almost no data available in the official statistics for these two countries on the penetration rates of relevant peripherals[6], these penetration rates are calculated as the relative shares compared to the existence of the main appliances (television, desktop computer). It was possible to derive this data from the REMODECE household metering survey, where data on penetration of various appliances was collected from 500 households (REMODECE 2008b)[7]. A typical site was thus created as one main appliance and the relative appearance of different types of relevant peripherals.

The total savings potential is corrected by deducting the savings relative to households which have already been using standby reduction devices ($1-P_{MS}$). Data on the usage of switched socket power boards was derived from the survey of the REMODECE project (REMODECE 2008b).

The economic feasibility of both switched socket power boards and standby killer is further assessed through the costs of conserved energy (CCE). The CCE formula helps to compare the saving measure with the electricity prices (Lung et al. 2005). The following equation has been used (based on Stoft 1995):

$$CCE_{site}(EUR/kWh) = \frac{AC_{sk}}{E_{site}}$$

2. Used as reference countries of Central and Eastern Europe.

3. Field data collection was undertaken by the Center for Climate Change and Sustainable Energy Policy of the Central European University as part of the international "basket of products" standby project, initiated by Energy Efficient Strategies Pty Ltd (EES) (Warragul, Victoria, Australia) as part of the Asia Pacific Partnership on Clean Development and Climate Change (APP) (CEU 2008).

4. Information on relevant modes can be found at the webpage of the project: http://www.energyrating.gov.au/standbydata

5. This is a device resembling an extension cord, which connects the main appliance (such as a TV) with its peripherals. When the main appliance is shut down, the device cuts the electricity from the peripherals, therefore saving the standby consumption. The advantage of the device is the convenience, often demanded by users, because the standby killer senses the remote switch on from the remote control (remote remains active).

6. The only data available is on DVD player penetration for Hungary in 2006. Nevertheless for the sake of consistency, all penetration rates are taken from one source: REMODECE project (REMODECE 2008b).

7. Due to financial and organizational limitations, the sample in both countries was collected by method of convenience sampling, and thus it is necessary to use and interpret the data with respective caution.

where $AC_{sk} = \frac{C \cdot d}{1-(1+d)^{-n}}$

and $E_{site} = E_{main} + \sum (E_{ap} \cdot P_{ap})$

Where:

CCE_{site} = cost of conserved energy for the site, for which the standby reduction device is used
AC_{sk} = annualized costs of a standby reduction device/ switched socket power board (EUR/year)
E_{site} = electricity saved per year per one site (kWh/year)
E_{ap} = average standby electricity consumption of one appliance from the site (kWh/year)
E_{main} = average standby electricity consumption of the main appliance of the site (television, desktops) (kWh/year)
P_{ap} = relative penetration rate of the particular peripheral appliance compared to the main appliance (REMODECE 2008a)
C = cost of a standby reduction device (EUR)
d = annual discount rate (3% for the Czech Republic and 4% for Hungary)
n = lifetime of a standby reduction device, e.g. duration of the conservation measure

The cost of conserved energy means the annualized costs of the particular standby reduction device divided by the saved electricity consumption of a site, for which it is used. The annualized costs depend on three factors: the cost and lifetime of the device and the discount rate. The cost of currently available standby killers ranges from 10 Euro (for office equipment) to 12 Euro (for a television site). The average life time of the device is 5 years (SavePower n.d.). The switched socket power boards cost around 6 Euro on average and can be used both for office site and television site, but rely more on consumer interaction to minimize standby.

Standby power levels of appliances on electronics store display

Power data by relevant modes for new home entertainment and office equipment, as measured in retail shops in Hungary and Czech Republic in 2008 are presented in figures 1 and 2.

HOME ENTERTAINMENT

The average passive standby[8] power of CRT TVs was about 4 times higher than that of the other technologies, LCD and plasma, therefore savings by switching off is more significant in case of the old (CRT) televisions. A reduction from standby power to off power by simple behaviour change in case of LCD and plasma TVs is hurdled because these are often equipped with no, or hard to reach off switches, however the power difference between standby and off mode is minimal in many products (Figure 1).

VCRs were practically non-existent in the stores, unless combined with DVD players; their penetration in the households is expected to drop. HDRs are still rare, but have been growing in availability and penetration in Central Eastern Europe. Power data for these appliances are also presented in Figure 1. Both active[9] and passive standby modes of DVDs and the like devices are often used by consumers, and while they may appear to be switched off, in fact energy is being consumed, but no main function is being performed. Products frequently have only a standby switch and cannot be put in off mode by the user, which represents a gap of saving potential even for consumers who would be willing to act.

The penetration of set top boxes in households is increasing quickly. They were considered in this study, because, with the upcoming transition to digital broadcasting, these devices are expected to be commonly used in households. The average power in on mode and passive standby mode was very similar, 6.9 W and 5.7 W respectively.

OFFICE EQUIPMENT

Desktop computers, the main appliance of an office, could not be metered because these are not commonly sold in electronics stores. Consumers usually buy them in pieces, build the computer with the hardware parts they need. For the calculation of the energy saving potential, data were taken from the REMODECE project, where the measurements were carried out in homes. The average off mode power of desktop computers was 3 W.

Some form of output device must be associated with a desktop computer, which is typically a monitor. The retail outlets visited did not offer the CRT monitors anymore, only LCD monitors were available. Monitors had almost the same power levels in off and passive standby modes (Figure 2).

Many household computer sites already include printers. The choices householders have are standard printer type (inkjet and laser printers) or the more complex multi function device (MFD)[10].

Printers, when not in use, are either switched off with the power switch (off mode), or are left on-line (active standby mode) – some printers have power management functions that revert to low levels after some time of no use. As seen in Figure 2, switching off is particularly effective in reducing power in case of laser printers. Inkjet printers and MFDs tend to feature a non-zero off mode power. Inkjet printers had a standby power that is three times higher than the off mode power. In case of MFD, both values were higher, especially when a display was present on the device. It is important to note that MFDs usually incorporate a fax machine and/or answering machine function and if this is required by the user, then the product has to be left in active mode all the time, and the standby reduction devices suggested by the authors are not useful.

Personal computers in the homes are commonly equipped with speakers. While these are plugged in the computer, they usually have separate power supply. These appliances also offer

8. When the appliance is switched off with the remote control.

9. Active standby mode is when the appliance is on but performs no task. For example, a "no disk" message in case of DVDs appears on the display, indicating that the appliance is ready to start.

10. Multifunction devices are equipment that can perform a variety of office tasks, such as printing, scanning, copying, sometimes even faxing and phoning.

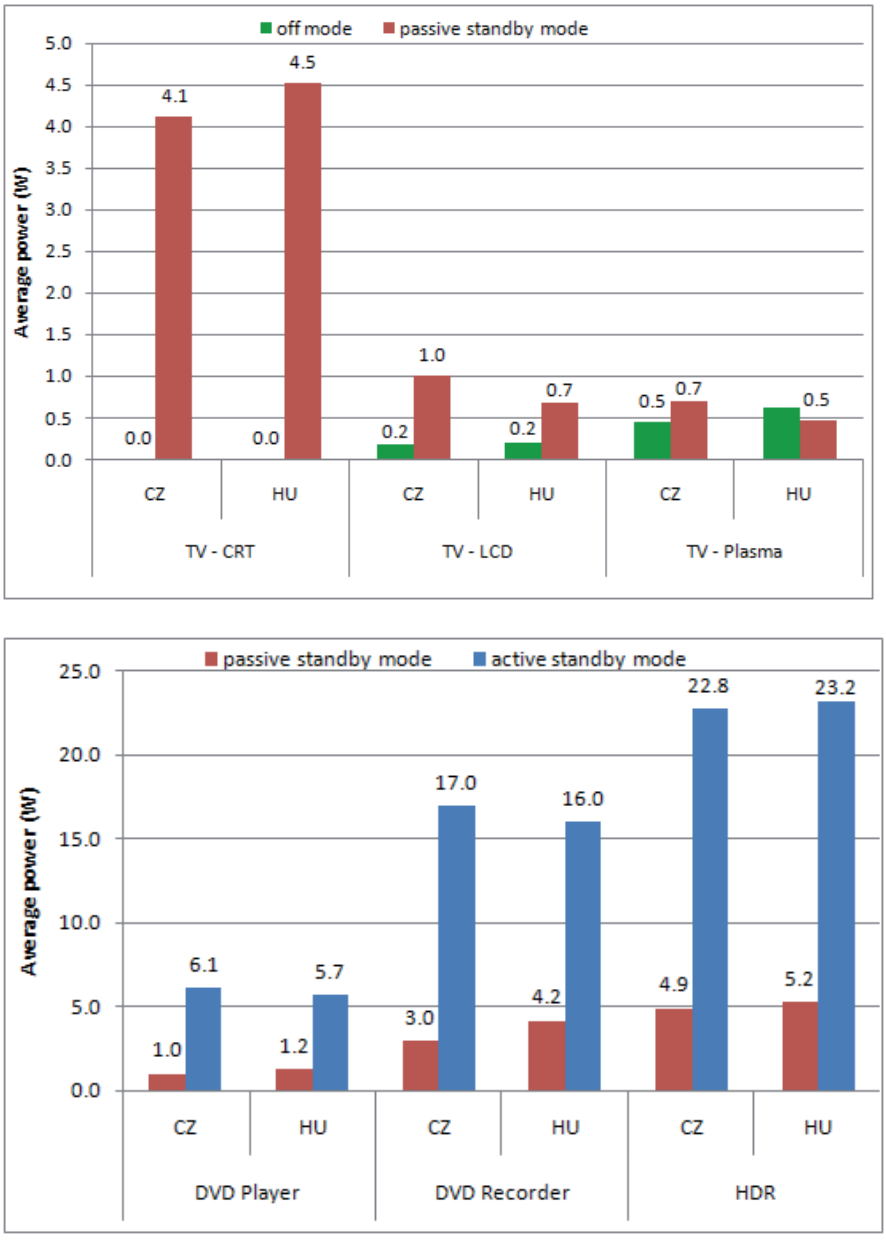

Figure 1. Average powers of off mode and passive standby mode of TVs (left). Average powers of passive standby modes of DVD players, recorders and HDRs (right). Note: labels on top of the columns indicate the power in Watt. CZ = Czech Republic, HU = Hungary

savings by provision of a separate power switch (or a standby reduction device), as both the standby mode power and the off mode are non-zero values.

Energy savings potentials through use of simple reduction devices

Once the customers buy the appliances, the consumption will solely depend on them: on their information, willingness and the technical options available. It is clear that in modern homes people are reluctant to sacrifice comfort and convenience by switching off equipment manually. This implies that preferred solutions will be to be able to manage all appliances at the same time and/or to use remote controls. Technological improvement, partially pressed by regulatory changes can force to modify the energy characteristics of new products and lower the standby power. However, first, the complexity of low power mode at new appliances (especially the network modes, so far excerpt from the regulation) is still likely to offer a saving potential. Secondly, existing stock and equipment purchased until the regulation still have poor standby power attributes, and offer a gap to act upon. A solution to this problem could be the employment of standby reduction devices, such as switched socket power boards or the more sophisticated standby killers.

Yet, it appears that there are several reasons that may prevent a larger penetration of the standby reduction devices into the market. The major barriers are the need for behavioural changes in case of switched socket power boards both to purchase and use them, lack of information both on the importance/magnitude of standby consumption and the possibility to reduce it, the trivial value of individual standby consumption (though

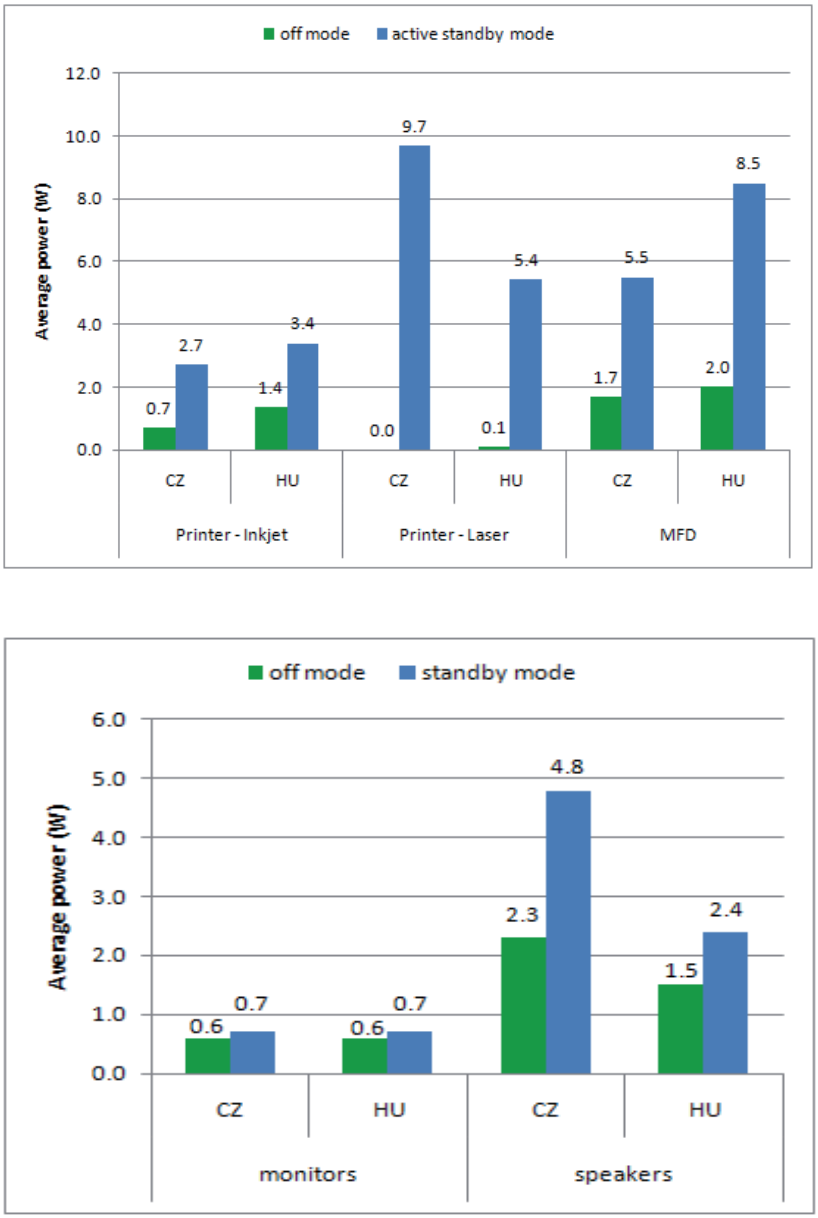

Figure 2. Average powers of off mode and active standby modes of printers and MFD (left). Average powers of off mode and passive standby modes of monitors vs. active standby modes of computer speakers (right). Note: labels on top of the columns indicate the power in Watt. CZ = Czech Republic, HU = Hungary

on national and even sometimes on the household level this is significant), and (as a result) the lack of supply of more sophisticated standby killers on the market. These devices should be more effective than manual switching as they generally do not require direct user intervention for them to be effective.

The level of electricity savings taking into account the willingness to use switched socket power boards is shown in Table 1.

Surveys have been carried out in the Czech Republic and Hungary (REMODECE 2008a) to determine the awareness on standby energy consumption and to assess consumers' willingness to act. In the surveys, more than half of the respondents (51.3% in Czech survey and 54.4% in Hungary) claimed to have already been using the switched socket power boards to disconnect the appliances from the mains when not in use. Taking into account that half of the sampled population in both countries already possesses switched socket power boards, the overall national potential savings from all domestic television and office sites are 111 GWh/year in Hungary and 131 GWh/year in the Czech Republic. To compare, this amount of electricity would be also saved if all the households in the respective country completely stopped using electricity for one whole day (including electric heating and water heating).

In Hungary out of those 54% of respondents that use the power boards only 23% specifically use them to save electricity, while the other 30% indicated other reasons, such as safety. It is then probable that the switch is actually not being used to save energy (REMODECE 2008b). Moreover, the actual penetration of the switched socket power boards on national level might be lower than in the survey sample, mostly due to sampling methods and sample characteristics of the surveys in both countries,

Table 1. Potential electricity savings using standby reduction device

	Electricity savings – TV site (kWh/year)	Electricity savings – PC site (kWh/year)	Usage of standby reduction device in households (%)	Overall national potential savings from TV and PC sites (GWh/year)
Hungary	25.27	27.20	54.4	110.9
Czech Republic	36.66	29.95	51.3	131.2

Table 2. Cost of conserved energy of standby reduction devices – television site

	Cost of a standby killer (EUR)	Cost of switched socket power boards (EUR)	Electricity savings per site (kWh/year)	CCE for standby killer (EUR/kWh)	CCE for switched socket power boards (EUR/kWh)
Hungary	12	6	25.27	0.11	0.05
Czech Republic	12	6	36.66	0,07	0.04

Table 3. Cost of conserved energy of standby reduction devices – office site

	Cost of a standby killer (EUR)	Cost of switched socket power boards (EUR)	Electricity savings per site (kWh/year)	CCE for standby killer (EUR/kWh)	CCE for switched socket power boards (EUR/kWh)
Hungary	10	6	27.20	0.08	0.05
Czech Republic	10	6	29.95	0.07	0.04

which favoured respondents with an existing strong interest in energy and energy savings (see note 7). Given these assumptions and limitations, the savings potential stated above is likely to be underestimated.

The savings resulting from usage of a standby reduction device are obvious. Yet, even when the households are aware of the possibility to reduce standby power levels, the major concern among consumers is the loss of convenience in case of switched socket power boards (need to switch the power supply manually) and also the economic effectiveness of the measure. According to respondents in the Hungarian survey, the households would be willing to start using the standby reduction devices "if it was economically beneficial" and/or if "the appliances switched on and off automatically", thus if the usage was more convenient.

The concern for the inconvenience of using switched socket power boards is solved in the case of the more sophisticated standby killer, as the user does not suffer a reduction in convenience, because these devices are controlled with a remote. The economic feasibility of both standby reduction devices is further examined below.

Tables 2[11] and 3 show that in both countries, both standby reduction devices are economically advantageous for the households as their cost of conserved energy is less than the normal household tariff. The average price of electricity for households is 0.17 Euro/kWh in both countries (ERO 2008 for the Czech Republic and ELMŰ 2009 for Hungary). The CCE in our case means that every kWh saved through the standby reduction device costs 0.04 to 0.08 Euro. Therefore the CCE shows it is "less expensive" to save the energy than to consume it. Therefore both standby reduction devices would be economically effective for an average home entertainment as well as office site.

Conclusions

The EU Eco-design Directive was adopted in 2005, which is a framework that obliges manufacturers of energy-using products to reduce energy need or environmental harm at the design phase. Under the Directive, the regulation on standby and off mode electric power consumption was adopted in December 2008 (EC 2008) and obliges significant reduction of off mode and standby mode powers in case of some appliances[12]. Nevertheless, even until this regulation takes effect, users could reduce their energy and therefore financial losses through simple measures. After the technological changes due to the Eco-design Directive, standby consumption is expected to drop considerably, but not completely, and there will still be way for consumer action. Such measures include using a switched socket power boards or a standby killer.

Our study revealed that in Central Eastern Europe, electricity savings potential exists from the use of the standby reduction devices at both sites under investigation, home entertainment and office equipment, and at the national level the energy saving and economic benefits are significant. It was found that households need to be reassured that the usage of standby devices will not be inconvenient and at the same time, will be economically justifiable in order to motivate them to curb standby

11. The set top boxes were not metered in Hungary. For the calculation, the Czech results on standby power levels were therefore used in this case.

12. A horizontal maximum power level is set for standby mode at 1 to 2 W and for off mode at 1 W from 2010. From 2013, the maximum power level will be 1 W or 0.5 W in standby mode and 0.5 W in off mode.

consumption. The study has shown that both conditions can be met either by using switched socket power boards or the standby killer. Even though power consumption in standby and other low power modes at individual appliances is small, it has been proved that using standby reduction devices at selected, appropriate set of appliances is economically feasible for the households. Considering that the penetration rate of a wide range of electronic devices in the home and their associated functionality is likely to increase in the future, the spread and popularisation of reduction devices might be an alternative solution for the standby consumption problem in households in the short and medium term.

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Acknowledgments

We would like to thank the REMODECE and Energy Efficient Strategies teams for their valuable support and for sharing the data from the relevant project with us. We are also grateful to the store standby metering teams in Hungary and the Czech Republic for their meticulous and precise work in collecting the up-to-date data from the stores. Finally, we would like to kindly acknowledge the help and assistance of the stores where the metering could take place.