Determining Appliance Standby Electricity Consumption for Turkish Households

Mustafa Cagri Sahin, Gul Nihal Gugul and Merih Aydinalp Koksal, Hacettepe University

ABSTRACT

Residential sector in Turkey accounts for about 25% of the national electricity consumption. Due to increase in household income levels and decrease in the costs of household appliances; a dramatic increase in appliance ownership has been observed in recent years. Studies on standby electricity consumption conducted in many countries show that standby electricity consumption accounts for about 7 to 15% of the total household electricity consumption. However, no study has yet been conducted to determine the amount and percentage of standby electricity consumption for Turkish households. In this study, surveys and standby measurements are conducted at 201 households in Ankara, Turkey. The survey is designed to obtain detailed information on appliance properties, electricity consumption behavior, economic and demographic data of households, and electrical bills. A total of 1421 appliance standby power measurements are conducted. The average household standby power and standby electricity consumption is estimated as 27 W and 134 kWh/yr, respectively. After determining the total household electricity consumption using data on appliances and lighting from the surveys, standby electricity consumption fraction is estimated as 5 %. Two scenarios are applied to determine the potential in reducing standby electricity consumption of the households and associated CO_2 emissions. It is found that average household electricity can be reduced by 48 - 100 kWh/yr. When these deductions are applied to all urban households in Turkey, the residential sector electricity consumption and total national CO_2 emissions can be reduced by 2.7 % – 5.7 % and 0.5 % – 1.1 %, respectively.

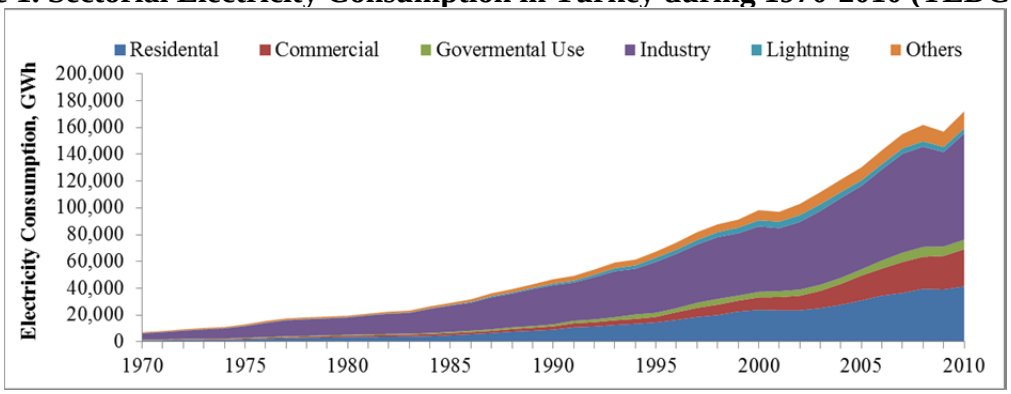
Introduction

Research on determining the electricity consumption of household appliances that were either switched off or not performing their main function started in early 1990's (Meier & Greenberg 1992; Meier, Rainer & Greenberg 1992; Sandberg 1993). Although there are currently many terms used for this end-use electricity consumption, standby electricity consumption (SEC) is the best known term currently used. Many more studies are later conducted to determine SEC consumption of various new and stock household appliances (Lane & Wajer 1997; Floyd & Webber 1998; Rosen & Meier 2000; Ross & Meier 2002; Meier & Nordman 2008; Hamer et al. 2008; Guan, Berrill & Brown 2011), amount of national SEC and standby power per household (Rainer, Greenberg & Meier 1996; Urge-Vorsatz, Sroukanska & Asztalos 2002; Fung et al. 2003; Meier et al. 2004; Camilleri, Isaacs & French 2006; Bredekamp et al. 2006; Clement, Pardon & Driesen 2007; Kilpatrick et al. 2011; deAlmeida et al. 2011; Gram-Hanssen & Gudbjerg 2006), and associated CO_2 emissions (Lebot, Meier & Anglade 2000). Due to the increasing trend in electricity consumption of standby end-use, many countries and non governmental bodies have taken steps to reduce standby power of the appliances, such as enforcing a maximum standby power of one watt for all new appliances (Bertoldi, Conti & Berrutto 2000; Bertoldi et al. 2002; Holt & Harrington 2004; Meier 2005; Meier & Siderius

2006; Edlington et al. 2006; Harrington, Siderius & Ellis 2008; Blok 2005). The effects of these steps in reducing the household and national electricity consumption, electricity expenditures, and associated CO_2 emissions are also studied by many researchers (Sanchez et al. 1998; Urge-Vorsatz, Sroukanska & Asztalos 2002; Zyzniewski 2004; Gram-Hanssen & Gudbjerg 2006; Hamer et al. 2008; Guan, Berrill & Brown 2011; Meier et al. 2004).

The share of residential sector in total national electricity consumption has been increasing and currently accounts for about one fourth of the total electricity consumption in Turkey as presented in Figure 1.

Figure 1. Sectorial Electricity Consumption in Turkey during 1970-2010 (TEDC 2011)



Due to the significant increase in per capita income levels from $6257 in 1990 to $15,687 in 2010 (WorldBank 2011) and a decrease in the costs of household appliances; new appliance purchase rates have increased from 2.8 million in 2002 to 6.18 million in 2010 in Turkey (BeySad 2012). As the number of appliances increases, the amount of electricity consumed by appliances at standby mode also increases. To the authors' knowledge there is only one study that estimated the SEC for Turkish households which was based on bottom-up approach. In this study, as being one of the OECD countries with lowest GDP, Lebot et al. (2000) have assumed an average standby power of 10 W per household for Turkey for 1997. Also assuming that this standby electricity consumption is for 24 hours, the authors estimated that standby electricity accounts for 1.5 % of the total national electricity consumption in 1997. In another study conducted by International Energy Agency (IEA) in 2001, the standby power estimate for Turkey is taken as 20 W, which doubles the fraction to 3% (IEA 2001). Other than these studies, no other study has yet been conducted using either whole-house measurement or bottom-up approach to determine the amount and percentage of SEC for Turkish households.

In this study, the average standby power and energy consumption of Turkish households are determined using whole-house measurements approach. Surveys and measurements are conducted at 201 homes located in Ankara, the capital city of Turkey. The SEC fraction in the total household electricity consumption is also determined and compared with results of other whole-house measurements studies. Using survey and SEC measurements data, scenarios such as decreasing standby power to 1 W and replacing some of the existing appliances with newer ones are applied to determine the amount of reduction that could be obtained in total household electricity consumption and associated CO_2 emissions. These results are also extrapolated to the national urban housing stock to determine the reductions in national residential electricity consumption and total CO_2 emissions.

Methodology

The standby power studies are conducted using either whole-house measurements approach or bottom-up estimates approach. The whole-house measurements approach mostly involves visiting a number of sample houses, conducting a detailed survey about appliances and occupant electricity consumption behavior, and measuring standby power of the appliances in the household. The total household electricity consumption is calculated by using the survey and billing data of the households. The standby power determined from measurements is multiplied by the number of hours the appliance is left at standby mode, which was obtained from the surveys. The fraction of standby end use in the total household electricity consumption is also determined. Bottom-up estimates approach is used when detailed appliance saturation and appliance standby power data is available. In this approach, the appliance saturation data is multiplied by the average estimated appliance standby power and standby hours. This approach is accurate for common major appliances for which detailed stock data and measurements are available; but not accurate for minor appliances, which actually constitute most of the SEC of the households (Meier 2002).

The primary objective of this study is to determine average standby power and electricity consumption, and fraction of SEC to the total household electricity consumption for Turkish households using whole-house measurements approach. Thus, during house visits data on lighting and appliances of the household is documented, and all appliances with SEC are measured, where available (*i.e.* if the appliance is hard wired into the electrical system it is not measured, such as door bells, security alarms, intercoms, furnace/boilers). The standby power measurements are conducted with a true RMS power Extech 380803 power analyzer (Extech 2011). This is a dual range meter (0–200 and 200–2000 W) with 0.1 W resolution for the low range and 1 W resolution for the high range. The accuracy of the measurements is ±0.9% of reading + 0.4 W for the low range and ±0.9% of reading + 4 W. for the high range. The meter also has a built-in data logger, which can store up to 1012 readings during continuous data logging.

The volunteer households for the whole-house measurements are identified mainly based on their household income levels, since it is desired that the sample of this study would be a representative of the Turkish urban household stock. The other criterion is that these households do not use electricity for space heating. A survey with 45 questions and a section to tabulate the standby power measurements is prepared. The survey questions are prepared to get detailed information of the dwelling, occupants, appliances, appliance usage, billing data, and lighting (lamp power and usage). In addition to the surveys, the standby power measurements are also conducted at three electronics retail stores to determine the standby power of various new household electronic appliances available in the market.

In order to determine the total household electricity consumption, average electricity consumption of major household appliances are gathered from open literature based on their size, model, brand, age, *etc*. For example; the refrigerators are categorized based on their type (top or bottom freezer, single or two doors, etc.), volume, and age; and average annual electricity consumption for each category is determined from the web sites of local and international retailers and government agencies such as *Natural Resources of Canada* and *U.S. Federal Trade Commission*. The lighting and active appliance electricity consumption of each household is determined by multiplying the power of each lamp or appliance with its usage (number of hours per day). The total annual household electricity is then calculated by adding the lighting, active

and standby appliance electricity consumptions. This estimated total annual electricity consumption determined using the survey and appliance consumption data is then compared with the billing data, where available.

Two scenarios are applied to the survey data to determine the potential in reducing the SEC of the households. The scenarios are assuming maximum 1 W for all appliances and replacing some appliances with the newer ones available in the market. The average amount of reduction in SEC and associated CO_2 emissions are calculated based on these two scenarios. The emission factor for Turkey is taken as 476 kg CO_2/MWh, which is calculated by taking the fuel specific emission factors from (Ari & Aydinalp Koksal 2011) and 2011 electricity generation by primary energy resources data from Turkish Electricity Transmission Company (TETC 2012).

Results and Discussions

The results of this study are divided into two sections; namely appliance and household standby power statistics and scenarios to reduce standby power.

Appliance and Household Standby Power Statistics

A total of 201 homes are surveyed and standby measurements are conducted. Majority of the homes are apartments (93%), owner occupied (76%) with occupancy varying from one to seven persons, and on average 3.1 person per household. A total of 1421 appliances with SEC are identified and measured in the surveyed households. On average 7.3 appliances with standby power per household are measured. The number of measurements, average, maximum, and minimum standby power, usage and electricity consumption per appliance are tabulated in Table 1. The average standby power, usage, and consumption are calculated using Equation 1 based on measurement and survey data for 1421 appliances.

$$Y_i = \frac{\sum_{i=1}^{n} X_i}{n} \quad \text{(Eq. 1)}$$

where;

Y : average standby power, usage, or consumption of appliance i (W, hours, or kWh/year)

X: standby power, usage, or consumption per appliance i (W, hours, or kWh/year)

i : appliance type (*e.g.* TV, DVD, laptop, etc.)

n: total number of appliance i

The average standby power for DVD players and receivers are found to be lower than the values stated in (Rosen & Meier 2000; Zyzniewski 2004; Hamer et al. 2008; Bran et al. 2006), since DVD players are found in this survey were purchased by households in more recent years and exhibit lower standby power. The ranges of the standby power for the remaining appliances are similar to those reported in (Rosen & Meier 2000; Zyzniewski 2004; Camilleri, Isaacs & French 2006; Clement, Pardon & Driesen 2007).

The appliance with the highest standby power and electricity consumption is the satellite receiver (decoder) which has 82% saturation and on standby mode on average 14.5 hours a day in the surveyed households. CRT TVs have the highest saturation (124%) and the second highest standby power. The standby electricity consumption of CRT TVs is not high due to their low

standby usage (average 8.9 hours per day). This is probably because these old technology TVs are typically not the main TVs of the households and have easy to reach on/off buttons. Thus the occupants can easily turn them off at night time. Modems/routers are the second highest standby electricity consuming appliances in the surveyed households with a saturation of 56% and left on standby mode on average 15.5 hours per day. Unlike U.S., majority of the washing machines and dishwashers in Turkey are not built-in, therefore each appliance has its own on/off switch button. Thus, SEC of these appliances given in Table 1 is due to the hours in which appliance is at standby mode after it completed its cycle.

Table 1. Measured Appliance Standby Power, Usage, and Electricity Consumption

Appliance	#	Standby Power (W)			Standby Usage (hr/day)			SEC (kWh/year)		
		Min.	Avg.	Max.	Min.	Avg.	Max.	Min.	Avg.	Max.
CRT TV	249	0.0	5.1	21.9	0.0	8.9	24.0	0.0	16.6	175.2
LCD TV	106	0.0	1.8	13.6	0.0	13.0	23.0	0.0	7.9	109.2
Plasma TV	16	0.4	4.7	19.0	0.0	13.3	23.6	0.0	22.5	90.5
LED TV	8	0.0	0.3	0.9	0.0	9.9	19.0	0.0	1.2	3.9
Satellite Receiver	164	0.0	7.5	23.1	0	14.5	24	0.0	40.5	142.6
Cordless Phone	103	0.3	2.4	6.0	0	23.2	24.0	0.0	20.4	50.4
StereoTape/CDPlayer	46	0.1	3.2	9.4	0	15.2	24	0.0	17.4	75.5
Home Theater	8	0.5	1.7	7.5	0	9.4	22	0.0	5.2	19.2
Radio	21	0.0	1.9	5.1	0	14.5	24	0.0	9.9	29.4
Alarm Clock	7	0.0	1.9	4.0	0	1.9	4	0.0	15.9	32.1
DVD/VCD Player	65	0.0	2.7	12.5	0	14.3	24	0.0	8.8	77.1
Desktop PC	79	0.1	3.4	15.0	0	12.6	24	0.0	12.5	44.2
Computer Monitor	76	0.2	2.4	12.4	0	12.2	24	0.0	9.6	99.6
Modem/Router	113	0.1	4.6	8.3	0	15.5	24	0.0	25.9	59.2
Printer/Scanner	30	0.2	2.6	8.2	0	13.0	24	0.0	12.3	71.8
Notebook	79	0.3	3.0	20.0	0	5.7	24	0.0	3.9	39.4
Clothe Washer	16	0.9	1.5	2.0	0	3.8	24	0.0	1.7	7.9
Clothe Dryer	1	2.0	2.0	2.0	3	3.0	3	2.2	2.2	2.2
Dishwasher	14	1.0	2.0	3.0	0	2.0	3	0.0	1.9	3.0
Microwave	13	0.1	1.4	2.4	24	23.9	24	1.0	12.4	21.0
Oven	27	0.7	1.6	3.2	1	22.3	24	0.4	13.1	28.0
Air Conditioner	1	2.1	2.1	2.1	24	24.0	24	18.4	18.4	18.4
Furnace	73	1.5	2.5	4.5	0	22.9	24	0.0	21.0	37.8
Rech. Vac. Cleaner	50	0.9	3.2	5.8	0	20.2	24	0.0	23.0	50.8
Home Audio Sys.	41	0.2	3.3	12.4	0	18.3	24	0.0	18.6	56.9
Game Console	8	0.1	1.6	5.1	5	19.3	24	1.1	19.3	26.3
Water Dispenser	7	0.5	2.5	7.5	0	20.6	24	0.0	21.2	65.7

The distribution of total household standby power and electricity consumption are presented in Figure 2. The average standby power and consumption per household is calculated using Equation 2.

$$T_i = \frac{\sum_{i=1}^{n} H}{n} \quad \text{(Eq. 2)}$$

where;

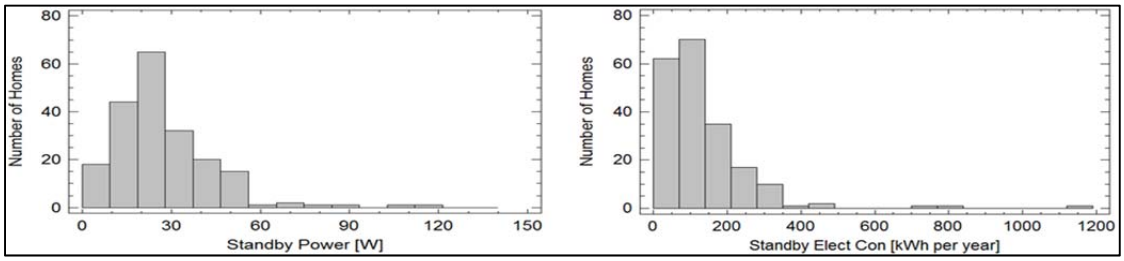
T : average household standby power or consumption (W or kWh/year)

H: total standby power or consumption per household (W or kWh/year)

i: household number
n: total number of households

The average household standby power is 27 W and the maximum is 120 W. The majority of the surveyed households have a standby power between 10 and 50 W. The standby electricity consumption distribution is similar to that of standby power. The average standby electricity consumption per household is 134 kWh/yr and the maximum is 1180 kWh/yr. As also seen from the figure, the majority of the surveyed households have standby electricity consumptions between 50 and 300 kWh/yr.

Figure 2. Distribution of Total Standby Power and Electricity Consumption of the Households



The effect of income on SEC is also studied. As presented in Table 2, as the income level increases the number of appliance with standby, total household standby power, and also SEC per household increases. The effect of income on SEC was also studied by (Gram-Hanssen, Kofod & Petersen 2004), and the authors determined that as the household income increases the SEC also increases in the surveyed households.

Table 2. Appliance Standby Power, Usage, and Electricity Use Based on Income Level

Net Monthly Income	# HHs Surveyed	Avg. # Appliances with Standby	Avg. Standby Power, W	Avg. SEC, kWh/yr
1 - < 1 250 TL ($700)	40	5	21	80
2 – 1 250 ($700) –-2 500 TL ($1 400)	68	6	23	111
3 – 2 500 ($1 400) – 5 000 TL ($2 800)	59	8	29	133
4 – 5 000 ($2 800) – 8 000 TL ($4 500)	27	10	34	167
5 - > 8 000 TL ($4 500)	7	28	63	445
Overall Average		7	27	134

To determine the fraction of SEC in the total household electricity consumption, the lighting and active appliance end-uses are calculated for each household and summed with the SEC. The average annual household electricity consumption is determined as 2728 kWh/yr. This presents that the average household SEC is 5% of the total household electricity consumption for the surveyed households.

The results of some whole-house measurement studies including this study are presented in Table 3. The ranges of the results are very wide. The ranges for the number of homes surveyed, average standby power, average SEC, SEC fraction, number of appliances with standby per household, and number of appliance with standby measured are between 1-1300 homes, 14-125 W, 100-1015 kWh/yr, 5-15%, 3.2-19 appliances per household, and 80-11,500 appliances, respectively. The whole-house measurement approach involves uncertainties mainly

due to defining and measuring standby power. Each study has its own definition for standby and conducts measurements based on the appliances that fit in their definition. Some studies included continuous and hard wired appliance standby loads, which resulted in higher estimate for standby power. In some studies, only large appliances are measured and smaller electronic appliances are ignored, which led to lower estimates of standby power (Meier 2005).

Table 3. Results of Some Whole-House Measurement Studies

Country / Region	Year	# HHs	Avg. Standby Power, W	Avg. SEC, kWh/yr	SEC Fraction of total, %	Avg. # Appl. with Standby, per HH	# Appl. with Standby
Japan*	1997	36	60	530	12%		
Sweden*	1997	1	80	475			
France*	1999	178	38	235	7%		
France / Paris*	1999	1	70	600			
Japan / Tokyo*	1999	1	80	700			
New Zealand*	1999	29	100	880	11%		
Australia*	2000	64	87	760	12%		
Japan*	2000	42	45	398	9.4%		
United Kingdom*	2000	32	32	277			
USA/CA* (Ross & Meier 2002)	2000	10	67	590	9%	19	212
Australia*	2001	1	112	980			
Canada/Nova Scotia*	2001	79	38	329			
China/Beijing*	2001	42	33	N/A			
China/Guangzhou*	2001	115	35	N/A			
Denmark*	2001	100	60	482	14.4%		
Greece*	2001	100	50	424	13.5%		
Italy*	2001	100	57	472	15%		
Portugal*	2001	100	46	377	13.7%		
New Zealand / North Island*	2001	2	125	1015			
USA/California*	2001	4	115	1010			
USA/Colorado*	2001	5	46	405			
Bulgaria (Urge-Vorsatz, Sroukanska & Asztalos 2002)	2002	30	33	789	N/A	5.6	
Romania (Urge-Vorsatz, Sroukanska & Asztalos 2002)	2002	30	14	340	7.3%	3.2	406
Hungary (Urge-Vorsatz, Sroukanska & Asztalos 2002)	2002	39	30	709	11.5%	3.7	
China/Guangzhou (Meier et al. 2004)	2004	28	29	100	4-16%		
USA/California (Nordman, Biermayer & Homan 2004)	2004	8	90				269
Denmark (Gram-Hanssen & Gudbjerg 2006)	2005	30	67	120-980	2-18%		
New Zealand (Camilleri, Isaacs & French 2006)	2005	398	57±4			14.2	5656
Australia (Edlington et al. 2006)	2005	120	85.3		10.3%	6.7	
Argentina (Tanides 2008)	2007	15	23.1		7.7%	12.5	
Belgium (Clement, Pardon & Driesen 2007)	2007	10	40-50	274-435	8 – 12%		80
12 European countries** (deAlmeida et al. 2011)	2009	1300	39.8	305	11%		11,500
This Study	2011-2012	201	27	130	5%	7.3	1421

*Sources: (Lebot, Meier & Anglade 2000; Bertoldi et al. 2002; Meier 2002; Holt & Harrington 2004; Clement, Pardon & Driesen 2007)

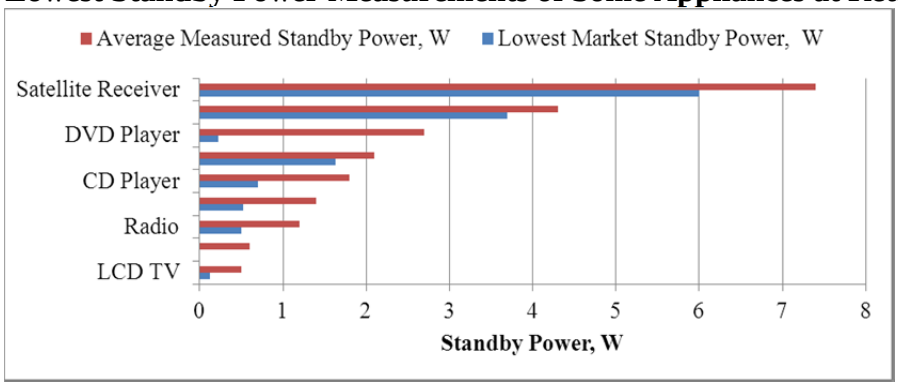
**Belgium, Bulgaria, Czech Rep, Denmark, France, Germany, Greece, Hungary, Italy, Norway, Portugal, Romania

This study resulted in one of the lowest standby power, SEC, and SEC fraction values as presented Table 3. This is probably due to the appliances included for measurement in this study. In order to not to inconvenience the occupants and also due to measurement difficulty, most major and hard wired appliances were not measured. Also, the income level of average Turkish households is lower than most of the nations listed in Table 3 in which standby studies are conducted. Thus, a lower standby power result is expected. The SEC results are also lower due to the electricity consumption habits of Turkish households. Most occupants surveyed turn off or unplug their appliances for a safety measure to protect them against voltage fluctuations. This habit reduces the SEC and SEC fraction estimates.

Scenarios to Reduce Standby Power

As stated previously, two scenarios are applied to the surveyed data to determine the potential electricity savings and reduction in associated CO_2 emissions. The first scenario is applying a maximum standby power of 1 W for all appliances in the household with standby load. The other scenario is replacing some of the appliances with newer ones. To obtain the standby power of some appliances on the market, standby power measurements at three retail stores are conducted. The lowest measured standby power of each new appliance is used in the scenario analysis. These market values are presented in Figure 3 along with average measured standby powers obtained from the surveyed households. As seen here, the standby power values that are used in the scenario analysis are lower than the average measured ones.

Figure 3. Lowest Standby Power Measurements of Some Appliances at Retail Stores



The SEC of the households are calculated based on the scenarios assumptions. The number of households that the scenarios are applied, average SEC per household after applying the scenarios, change in SEC per household, and associated CO_2 emission are tabulated in Table 4. As presented in Table 4, 1 W scenario results in larger reduction in SEC per household than the new appliances scenario. Even though many of the appliances currently available in the market have standby power loads lower than 1 W, applying new appliances scenario would be a more appropriate target for Turkish residential sector than the 1 W scenario since it would be harder to replace all appliances in a household at one time. Currently, only new TV's have standby power less than 1 W, as presented in Figure 3. Other appliances have higher standby power. Especially the new satellite receivers and modems which have %80 and %55 saturations,

respectively, have higher standby powers than other appliances listed in Table 4. Thus, it would be beneficial to set up a policy action especially for receivers and models available in Turkish market.

Table 4. Results of the Scenarios

	# HHs Applied	Avg. SEC per HH, kWh/yr	Avg. Reduction in SEC per HH, kWh/yr	Associated CO_2 Emissions Reduction. kg CO_2 per HH
1 W Scenario	193	139	100	48
New Appliances Scenario	191	140	48	23

The number of urban households is determined as 22,278,548 in 2011 for Turkey (TurkStat 2012). Applying these scenarios to all urban households in Turkey would result in reductions of 1069 – 2228 GWh of residential electricity consumption, and 512 – 1069 thousand tons of CO_2 emissions based on new appliance and 1 W scenario, respectively. The residential electricity consumption in Turkey was 39,147.5 GWh (TEDC 2011) and electricity generation associated CO_2 emission was estimated as 101 million tons for 2009 (Ari & Aydinalp Koksal 2011). Applying these scenarios would then reduce national residential electricity consumption by 2.7 % – 5.7 %, and electricity generation associated CO_2 emissions by 0.5 % – 1.1 % based on new appliance and 1 W scenarios, respectively. This would also provide a reduction of 321-668 million TL (178 – 371 million USD) in electricity expenditures for Turkey.

Conclusions

Turkey's rapidly growing population and economy have fueled a rapidly growing demand for electricity, especially in the residential sector. The increase in household income levels and decrease in appliance costs have resulted in a dramatic increase in the number of appliances. Thus, the share of appliance electricity consumption has been increasing in the Turkish housing sector. Nevertheless, the appliance electricity consumption end-use has not been yet investigated for the Turkish households. Actions targeting losses in this sector, such as standby losses, should be taken shortly to make an important difference in Turkey electricity demand.

In this study, to the authors' knowledge for the first time, average standby power and SEC of Turkish households, and the fraction SEC in the total electricity consumption are determined using whole-house measurements approach and scenarios are applied to determine reductions in household SEC. The study is conducted by surveying 201 homes. A total of 1421 appliance standby power measurements are conducted, which makes about seven appliances with standby per household. The satellite receiver was found to be the appliance with the highest average standby power and also SEC due to its high saturation and standby hours. The average total household standby power, SEC, and SEC fraction of the total household electricity consumption are determined as 27 W, 120 kWh/yr, and 5%, respectively. The estimated standby power found in this study is estimated higher than the value estimated for Turkey by (IEA 2001), but lower than majority of the other national/regional values. It is difficult to compare the standby estimates since each study has its own standby definition and measurement protocol.

The potential in reducing the standby end-use in the housing stock is also studied. Allowing maximum one watt for all appliances and replacing some appliances with the newer ones scenarios are applied to all surveyed households. It is found that the national residential

electricity consumption can be reduced by 2.7 % – 5.7 % and electricity generation associated CO_2 emissions by 0.5 % – 1.1 % based on new appliance and 1 W scenarios, respectively.

Acknowledgement

This study is funded by The Scientific and Technological Research Council of Turkey (TUBITAK). The authors would like to acknowledge TUBITAK for their financial support. The authors would like to thank Mr. Cem Ural and Mr. Fatih Ozkadi from ARCELIK for their help in providing new appliance standby power measurements.

References

Ari, I & Aydinalp Koksal, M 2011, 'Carbon Dioxide Emission from the Turkish Electricity Sector and its Mitigation Options', *Energy Policy*, vol 39, pp. 6120-6135.

Bertoldi, P, Aebisher, B, Edlington, C, Heshberg, C, Lebot, B, Lin, J, Marker, TMA, Nakagami, H, Shibata, YSH & Webber, C 2002, 'Standby Power Use: How Big Is the Problem? What Policies and Technical Solutions Can Address It?', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Bertoldi, P, Conti, F & Berrutto, V 2000, 'The European Strategy for Reducing Stand-By Losses in Consumer Electronics: Status and Results', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

BeySad, 2012, Appliance Purchase Rates (in Turkish), viewed 5 May 2012, <http://www.beysad.org.tr/Dergi/index.html#/category>.

Blok, K 2005, 'Enhanced Policies for the Improvement of Electricity Efficiencies', *Energy Policy*, vol 33, pp. 1635-1641.

Bran, I, Luo, J, Webber, C & Lin, J 2006, 'Plug Loads and Energy Efficiency Programs: Focusing on the U.S. and China', *In Proceedings of the ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Bredekamp, A, Uken, EA & Borrill, L 2006, 'Standby Power Consumption of Domestic Appliances in South Africa', *Proceedings of the Domestic Use of Energy Conference*, Cape Town, South Africa.

Camilleri, M, Isaacs, N & French, L 2006, 'Standby and Baseload in New Zealand Houses: A Nationwide Statistically Representative Study', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Clement, K, Pardon, I & Driesen, J 2007, 'Standby Power Consumption in Belgium', *Proceedings of the International Conference on Electrical Power Quality and Utilization*, Barcelona.

deAlmeida, A, Fonseca, P, Scholmann, B & Feilberg, N 2011, 'Characterization of the Household Electricity Consumption in the EU, Potential Energy Savings and Specific Policy Recommendations', *Energy and Buildings*, vol 43, pp. 1884-1894.

Edlington, C, Ryan, P, Damnics, M & Harrington, L 2006, 'Standby Trends in Australia and Mandatory Standby Power Proposals', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Extech 2011, *Power Analyzer*, viewed 5 January 2011, <http://www.tequipment.net/Extech380803.asp>.

Floyd, D & Webber, C 1998, 'Leaking Electricity: Individual Field Measurements of Consumer Electronics', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Fung, A, Aulenback, A, Ferguson, A & Ugursal, I 2003, 'Standby Power Requirements of Household Appliances in Canada', *Energy and Buildings*, vol 35, pp. 217-228.

Gram-Hanssen, K & Gudbjerg, E 2006, 'Reducing Standby Consumption in Households: By Means of Communication or Technology?', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Gram-Hanssen, K, Kofod, C & Petersen, KN 2004, 'Different Everyday Lives: Different Patterns of Electricity Use', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Guan, L, Berrill, T & Brown, RJ 2011, 'Measurement of Standby Power for Selected Electrical Appliances in Australia', *Energy and Buildings*, vol 43, pp. 485-490.

Hamer, G, Delves, K, Saint-Laurent, I, Peloquin, N, Vladimer, M & Scholand, M 2008, 'Canadian Standby Power Study of Consumer Electronics and Appliances', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Harrington, L, Siderius, H-P & Ellis, M 2008, 'Standby Power: Building a Coherent International Policy Framework', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Holt, S & Harrington, L 2004, 'Standby Power and How to Use Less of It', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

IEA 2001, *Things That Go Blip in the Night*, viewed 12 February 2012, <http://people.trentu.ca/rloney/files/blipinthenight01.pdf>.

Kilpatrick, RAR, Banfill, P.F.G. & Jenkins, DP 2011, 'Methodology for Characterising Domestic Electrical Demand by Usage Categories', *Applied Energy*, vol 88, pp. 612-621.

Lane, K & Wajer, BH 1997, 'Standby Consumption in TVs and VCRs: Lessons for Other Equipment with 'Leaking Electricity'', *Proceedings of 1997 ECEEE Summer Study*, European Council for an Energy Efficient Economy, Paris.

Lebot, B, Meier, A & Anglade, A 2000, 'Global Implications of Standby Power Use', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Meier, A 2002, 'A Worlwide Review of Standby Power Use in Homes', *In Proceedings of Symposium on Highly Efficient Use of Energy and Reduction of Its Environmental Impact*, Osaka, Japan.

Meier, A 2005, 'Standby: Where Are We Now?', *In Proceedings of 2005 ECEEE Summer Study*, European Council for an Energy Efficient Economy, Paris.

Meier, A & Greenberg, S 1992, 'Emerging Miscellaneous Uses of Electricity in Homes', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Meier, A, Lin, J, Liu, J & Li, T 2004, 'Standby Power Use in Chinese Homes', *Energy and Buildings*, vol 36, pp. 1211-1216.

Meier, A & Nordman, B 2008, 'Low Power Mode Energy Use in California Homes', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pasific Grove, CA.

Meier, A, Rainer, L & Greenberg, S 1992, 'Miscellaneous Electricity Energy Use in Homes', *Energy*, vol 17, no. 5, pp. 509-518.

Meier, A & Siderius, H-P 2006, 'Regulating Standby', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Nordman, B, Biermayer, P & Homan, G 2004, 'Any Device, Any Mode; Measuring All Residential Low-Power Mode Energy Consumption', *In Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Rainer, L, Greenberg, S & Meier, A 1996, 'You Won't Find These Leaks with a Blower Door: The Latest in "Leaking Electricity" in Homes', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

Rosen, K & Meier, A 2000, 'Power Measurements and National Energy Consumption of Televisions and Videocassette Recorders in the USA', *Energy*, vol 25, pp. 219-232.

Ross, JP & Meier, A 2002, 'Measurements of Whole-House Standby Power Consumption in California Homes', *Energy*, vol 27, pp. 861-868.

Sanchez, M, Koomey, J, Moezzi, M & Meier, AHW 1998, 'Miscellaneous Electricity in U.S. Homes; Historical Decomposition and Future Trends', *Energy Policy*, vol 26, no. 8, pp. 585-593.

Sandberg, E 1993, 'Electronic Home Equipment - Leaking Electricity', *Proceedings of 1993 ECEEE Summer Study* , European Council for an Energy Efficient Economy, Paris.

Tanides, CG 2008, 'Estimation of Standby Energy Consumption and Energy Saving Potential in Argentine Households', *Energy for Sustainable Development*, vol 12, no. 4, pp. 76-80.

TEDC 2011, *Turkish Electricity Distribution Company - Statistics (in Turkish)*, viewed 5 February 2012, <http://www.tedas.gov.tr/29,Istatistiki_Bilgiler.html>.

TETC 2012, *Turkish monthly electricity statistics (in Turkish)*, viewed 15 February 2012, <http://www.teias.gov.tr/AylikElektrikIstatistikleri/AylikElektrikIstatistikleri.xls>.

TurkStat 2012, *Population, Demography, Housing and Gender Statistics*, viewed 29 February 2012, <http://www.tuik.gov.tr/AltKategori.do?ust_id=11>.

Urge-Vorsatz, Sroukanska, K & Asztalos, S 2002, 'Standing By in Central Europe: A Survey of Hungarian, Romanian and Bulgarian Residences', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.

WorldBank 2011, *GDP per capita for countries*, viewed 5 May 2012, <http://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD>.

Zyzniewski, A 2004, 'Standby Power in the Residential Sector in Canada and Future Trends', *Proceedings of ACEEE Summer Study on Energy Efficiency in Buildings*, American Council for an Energy Efficient Economy, Pacific Grove, CA.