Estimation of Standby Power Consumption for Typical Office Appliances

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Abstract

Standby electricity is the energy consumed by appliances when they are switched off or not performing their principal function. In the past years, many consumers could simply unplug their appliances, assuming that their electricity consumption would just stop, but now, almost all the equipment left connected are drawing power 24 hours a day, often without the knowledge of the consumer. A single appliance draws relatively little standby power. However, when multiplying by the number of such appliances in an office or household and taking in consideration the amount of time each of them spends in standby, this energy consumption represents a significant fraction of total electricity use. In this paper we investigate the standby power consumption in four offices at "Fan S. Noli" University of Korça. In each office, we surveyed and measured each appliance's standby power consumption. The Standby power consumption of various office appliances was determined using an energy smart meter and data-logger connected with a computer. We present detailed field measurements for personal computers, network appliances, printers, copiers, and air condition systems. This group of four offices is too small to accurately represent the standby losses for every office, but it involves a great diversity of appliances and situations.

KEYWORDS-Standby power consumption, energy loss, office appliances, vampire power, leaking electricity, appliance efficiency.

I. INTRODUCTION

Standby power is a general term commonly used to describe the energy consumed by the e-appliances when they are not performing their principal function. Standby power is also referred to as vampire power or vampire draw [1]. Since two decades ago, it has been recognized that the energy consumption in standby power modes for electrical and electronic products is an important issue because it represents permanent loads (sometimes up to 24 hours per day) of a large number of products. Now standby power consumption is a global phenomenon because most of the electronic and other household appliances are manufactured by the large multinational companies and their products are identical across all countries. At first glance, the loss of such kind seems to be low, but combined effect of all appliances whose power consumption varying from less than 1 Watt to 30 Watts ishaving significant impact on total household electricity consumption [2].

National level research studies have shown that standby consumption makes 5-26% of total electrical energy consumption of a household [1]. International Energy Agency (IEA) estimated that the world standby power consumption is between 200 and 400 TWh. The importance of standby energy consumption is illustrated by the fact that the IEA estimates that, even with a continuation of all existing appliance policy measures, the electricity consumption for ICT and consumer electronics will grow by almost 800% from 1990 to 2030 [4]. Although IEA has predicted that the number of

networked devices such as smart phones, tablets and set-top boxes, could skyrocket from 14 billion in 2015 to 500 billion by 2050, driving dramatic increases in both energy demand and wasted energy [5]. With the 1 Watt Initiative that was launched by the IEA in 1999, the EU commission announced a directive that limits the standby power to maximum 1 W for all new household appliances and 2 W for devices that have displaying unit. From the beginning of 2013, this limitation would be 0.5 W and 1 W, respectively [6][7][8].

Office equipment is one of the fastest-growing electricity uses in commercial buildings over the world and, according to "American Council for an Energy-Efficient Economy" in the U.S., it directly consumes 7% of total commercial electric energy which translates into $1.8 billion in electricity costs to businesses [9]. Furthermore, energy consumption due to office equipment and related energy systems is expected to continue to increase. In this study, we examine energy use by office equipment and network equipment in four offices in "Fan S. Noli" University in Korça City, Albania. The standby power consumption of various office appliances was determined using an energy smart meter. The experimental results show that the standby power for various office appliances is a real concern.

II. EQUIPMENT POWER MODE DEFINITION

There are many terms used for power operating modes. To keep the terms consistent among all the equipment types we used them in accordance with the: Commission Regulation (EC) No1275/2008, and (EU) No 801/2013 [7][8]. The different mode definitions are as follows:

Off-mode – This mode defines the status in which the energy-using product is connected to a mains power source and is not providing any function except the capability to react to a user's action on a (soft) switch located on the energy-using product. To put the energy-using product into another mode, this (soft) switch has to be operated.

Passive standby mode - In this mode the appliance is put into low power mode by a certain means like switch or remote control, providing one of the following additional functions, not a main function. The appliance can be reactivated by soft or hard switch, remote control, internal sensor or timer.

Active standby mode - In this mode the appliance is on but not performing its main function. For example, a printer is ready but not printing or copying or the DVD may be on but is not playing or recording.

On mode (working) - In this mode the appliance provides one or more of its main functions.

III. METHODOLOGY

For each appliance, consumed power was measured while the appliance was in use, in standby (passive and/or active) and off, where applicable. We tried to perform as many measurement modes as possible in order to achieve the maximum information about products power consumption. We used a common measurement methodology and the same equipment in all measurements. The data were collected using the metering equipment EKM-OmniMeter I v.3. The meter was connected to the mains and to the computer(it can export data to computer in excel format through EKM Dash software). Then the product was plugged into the power cable connected to EKM meter through current transformer (CT) and the measurement can be started. See figure 1 for illustration.

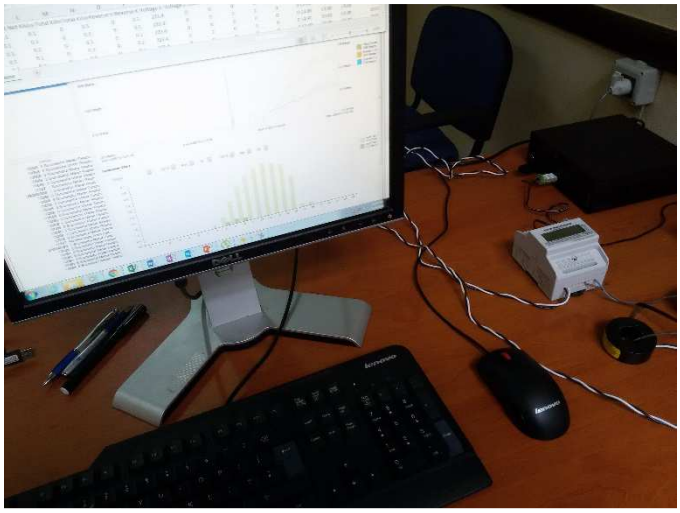

Figure. 1. Shows measurement procedures for Sharp-AR5618 copier.

We estimated the average power requirement in each mode, average usage (mode distribution over a week) depending on the equipment type and stability of the power consumption. The average values (voltage, power factor and active power) are then recorded automatically into the DASH software and then exported in the excel file. In total, 10 different products were measured resulting in 51 measurements recorded for all the relevant modes during the survey. Appliances were analyzed in terms of the values metered in each relevant mode.

IV. RESULTS

The primary results of the measurements are the power readings in various modes, such as "active standby", "passive standby", "off mode" and "on mode". An overview of the type of appliances measured, and the number of units with the relevant average powers for major modes is provided in Table 1. The table 1 summarizes those measurements, with the minimum, maximum, and average power levels observed in each mode.

Table 1.Measuring results for main office appliances.

Product/Mode	Min (watt)	Max (watt)	Average (watt)	No. of Equipment's measured
Computer Display, LCD				
On (working)	55	82	63	10
Off mode	0	0.5	0.2	
Passive standby	0.7	5.2	1.5	
Active standby	5.2	35	20	
Computer Desktop				
On (working)	45.4	120.5	75.3	10
Off mode	0.2	7.2	2.2	
Sleep	10.8	22.4	12.1	
Computer Notebook				
On (working), charged	20.6	45.2	30.1	7
On (working),	29.7	55.5	40.8	

charging				
Off mode, charging	10.2	15.7	13.1	
Sleep	12.9	28.4	17.4	
Power supply only	0.3	11.5	4.7	
Printer Laser				
On (working)	150.2	462.5	355.3	5
Off mode	0	1.2	0.2	
Passive standby	0.5	5.2	1.55	
Active standby	12	55.4	35.2	
Photocopier				
On (working)	650.4	945.6	815.3	4
Off mode	0	0.3	0.1	
Passive standby	5	12.2	7.1	
Active standby	85	105	92.3	
Scanner, flatbed				
On (working)	10.2	15.4	12.8	2
Passive standby	0.2	0.8	0.5	
Active standby	5.4	7.7	6.5	
Printer Inkjet				
On (working)	18	22	20	2
Off mode	0	1.2	0.6	
Active standby	1.5	2	1.7	
Switch (8-24 ports)				
On (working)	2.8	12	5.5	5
Active standby	0.9	2.5	1.7	
Modem, Cable				
On (working)	3.5	5.4	4.45	2
Active standby	3.2	5.1	4.15	
Air Conditioner				
On (heat mode, full speed)	1200	1850	1653	4
Active standby	45	78	62	

As seen in Table 1, the average active standby power of the 8 units is 29.2W, with large variations, ranging from 1.7W to 92.3W. The average of Passive standby mode power for the 7 relevant units is 5.2W, ranging from 0.5W to 13.1W, while the average off-mode power for the 7 relevant units is 2.3W, ranging from 0W to 13.1W.

The device with the highest input active standby power registered is a copier with 105W. Copiers, Laser printers and computer monitors are the products with the highest active standby measured input power. It should be noted that these high values can be dueto the product special features or even production defect. The outcomes showed that the input power values are higher compared to the EU regulation threshold of 0.5 and 1 Watt. Results are presented in figure 2.

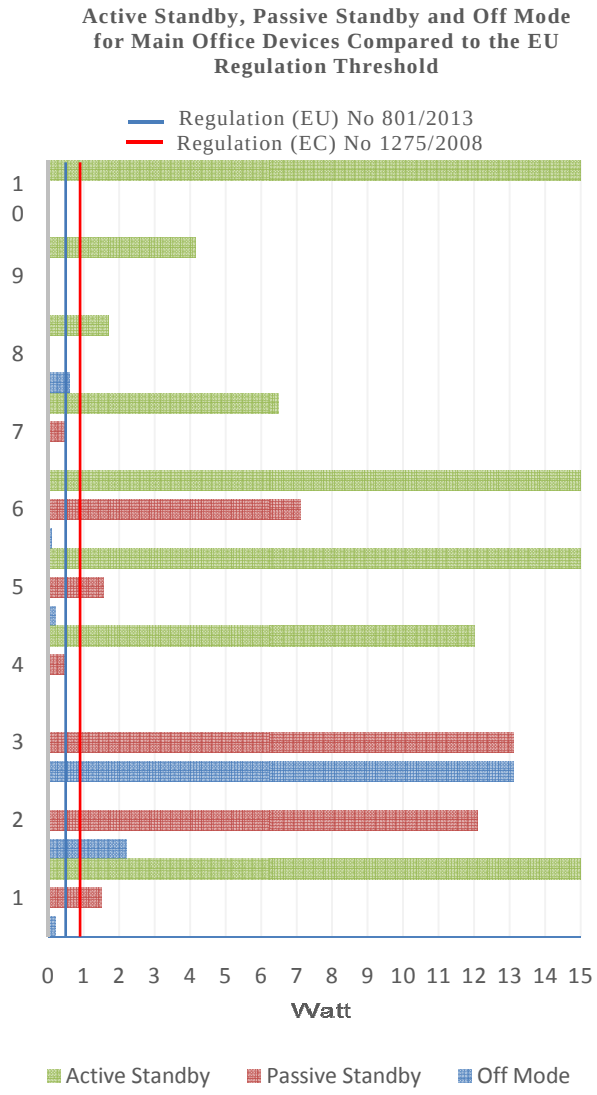

Figure 2. Active Standby, Passive Standby and Off Mode for Main Office Devices Compared to the EU Regulation Threshold

V. DISCUSSION AND RECOMMENDATIONS

There are simple, effective ways that office employees can use to save energy. We recommend the following energy saving tips:

Switch off the device when it is not in use, especially at night or at weekends, when possible. Switching the monitor or printer on and off several times per day will not damage them.

1. An effective way is using the intelligent power boards, which can turn off power to all peripherals and on again with one switch click or automatically.
2. Looking to the future consider choosing office equipment with a class A++ (low standby) energy efficiency.
   Choose ENERGY STAR. Look for the ENERGY STAR logo when buying office equipment. The logo ensures that the device has automatic power-management features and uses energy more efficiently.
3. Activate equipment power-management features.
   Use the “stand-by” and “sleep” modes available on the devices, especially for copiers and printers that are on all day but only used for a small part of the day.

Set the monitor's power management features to switch from active to sleep when you are not using it. Set the computer to sleep (hibernate) by saving all open programs on the computer's hard disk.

Save a tree and energy! Read email and documents directly from the computer monitor. It takes ten times as much energy to create a piece of paper than to put an image on it.

Think small! The most efficient computer is a laptop, which typically draws only 20 to 40 watts during use compared to the 150 watts used by a conventional PC and monitor.

Get the right size/type of device. Evaluate your needs and avoid purchasing more or less power and capacity than you need, particularly when buying copiers. A low-volume (20 copies per minute) copier in a low volume office can use less energy per page than a mid-volume (20-60 copies per minute) copier

Use ink jet printers; they use less energy than many of the current energy efficient laser printers.

Switch off network equipment when you're not using it. Around EUR 1 billion can be saved in the EU simply by disconnecting from the Internet when it is no longer in use. This is equivalent to 7.000 million kWh and 3,5 million tons of CO2. [10].

By observing the above recommendations energy can besaved for the benefit of the individual and of the whole nation.

REFERENCES

[1] http://en.wikipedia.org/wiki/Standby_power

[2] B. Mohanty, Standby Power Losses in Household Electrical Aplliances and office Equipment, The French Agency for the Environment and Energy Management, 2001.

[3] A. Prudenzi, A. Silvestri, R. Lamedica, M. C. Falvo, U. Grasselli, and M. Regoli, "Standby Power End Users and Their Demand Management Impact on Household's Load Shape," 2011 IEEE Power and Energy Society General Meeting, Detroit Michigan, USA, pp. 1–6, July 24-28, 2011.

[4] International Energy Agency (IEA),Projected IEA electricity consumption for ICT and CE equipment, 1990–2030 (IEA, 2009).

[5] International Energy Agency (IEA), More Data, Less Energy: Making network standby more efficient in billions of connected devices

[6] International Energy Agency(IEA), "Workshop on International Action to Reduce Standby Power Waste of Electrical Equipment" Proceedings on www.iea.org/standby/, 2009.

[7] Official Journal of the European Union, Commission Regulation (EC) No 1275/2008.

[8] Official Journal of the European Union, Commission Regulation (EC) No 801/2013.

[9] American Council for an Energy-Efficient Economy, http://aceee.org/topics/office-equipment.

[10] SELINA- Standby and Off-Mode Energy Losses In New Appliances Measured in Shops , Measured in Shops", Report elaborated for the EC, November 2009.