

# Energy Assessment on Standby Power Consumption of Common Household Electronic Appliances

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**Abstract:** - Most Filipinos in this modern generation have household appliances as a form of convenience in their daily lives. The usage of these common household appliances is indeed helpful, and they also play a huge part in the energy consumption of households. These appliances, despite not being used for some time, still consume energy when left unplugged, which is known as standby power consumption. A quantitative-descriptive survey questionnaire was used in the study to identify common household electrical appliances in the households. The power consumption of these appliances was measured and calculated for energy assessment. Using a digital energy logger, the measured power consumption shows that the standby power consumption ranges from 0.1 W to 3 W. These values are relatively small, but they become significant in the monthly or yearly possible energy savings of up to 3.34%. Thus, the study on the energy assessment of standby power consumption can provide insights and opportunities to reduce the residential demand for electricity. Household appliance manufacturers should take the lead in spreading awareness of the energy wasted on standby power through their product labels, encouraging residents to be more conscious of the power consumed by these plugged-in appliances when not in use.

**Key Words:** — *Household appliances, Energy consumption, Standby power, Energy savings.*

## I. INTRODUCTION

Most Filipino homes own at least one type of household appliance, particularly in this day where the means of daily living are done in a modern way with convenience. Refrigerators, televisions, microwaves, and even radios are a few of the numerous common household appliances that are being used. While these appliances are indeed useful, they are also accountable for 20 to 25 percent of the total home energy usage.

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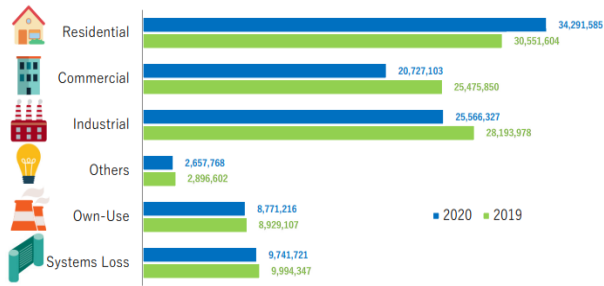
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The Philippine economy is seriously disrupted with lockdown and social distancing restrictions that forced people to stay at home to prevent the spreading of the COVID-19 infection. And these have reduced the demand for electricity in the industrial and commercial sectors, while residential power consumption has significantly increased, as expected in the current work-from-home and online class setup.

According to the Department of Energy's 2020 Power Situation report, total electricity sales and consumption in the Philippines fell by -4.0% to 101,756 GWh by the end of 2020, down from 106,041 GWh in 2019. This is because the Philippine economy declined by -8.3%, bringing a full-year reduction of -9.5% by the end of 2020.

The residential sector, as shown in Figure 1, continues to be the largest consumer, accounting for 33.7% of total electricity consumption (30,551,604 MWh), followed by the industrial sector (25.1%) and the commercial sector (20.4%) [1].



Note: Numbers may not sum up to total due to rounding off  
 "Others" refer to public buildings, street lights, irrigation, agriculture, and "others not elsewhere classified"

Fig.1. 2020 vs.2019 Philippines Electricity Sales and Consumption by Sector, Philippines (MWh)

Department of Energy Secretary Alfonso G. Cusi urged consumers to be mindful of their power consumption habits, especially during this pandemic. He stated that consciousness will help keep the electricity bills under control and contribute to effective household energy management [2].

Household power consumption is significantly affected by the behavior of the consumers. The habit of leaving the appliances unattended, either they forgot to unplug or turn off when not using it. Residents just realize their consumption once they receive their monthly electric bill, which shows the total power consumption in kilowatt-hours.

In a typical household, there are about fifty appliances and devices that utilize energy even when they seem to be off. Standby power consumption is known for televisions, DVD players, cable boxes, game consoles, chargers, monitors, fax machines, and many other common household electronic devices. Currently, household appliances like washers, dryers, microwave ovens, and refrigerators now have digital displays, electronic controls, and even internet connectivity. Furthermore, with conveniences like heated towel racks, toilet seats, and bathroom floors increasing in popularity, and many continue to draw significant amounts of power even when not in use [3].

However, when consumers do not know which appliances consume more energy, it may result in the excessive use of electricity. Additionally, residential consumers are unaware of how much power their electronic appliances are consuming while in standby mode. This is called "vampire" or "standby" power.

The average standby power ranges from 2 to 10 watts, or 6 to 10% of appliance usage. The electric cost of an electronic appliance in standby mode is relatively small but becomes a significant waste of money once it adds up [4]. Household appliances that are left in standby mode for 10 hours or longer each day use more than 109.5 kilowatt-hours in a year. Moreover, standby power increases proportionally to the number of appliances used in the household [5].

There are relatively few studies that have conducted energy assessments on the standby power consumption of household electronic appliances in the Philippines. For this reason, the researchers aim to assess the standby power consumption of common household electronic appliances. Specifically, the research focuses on identifying which of these appliances have standby power consumption. The study also determines the estimated energy savings if no power is consumed in standby mode.

Standby power is a growing challenge on a global scale. In the different studies conducted in Germany, Japan, the Netherlands, and the United States, up to 10% of all household electricity use is accounted for by standby power. There are few measurements of the total standby power consumption in individual homes, though these research and others have generated standby power consumption measurements for thousands of appliances [6].

The standby power management system was able to adapt to a constantly changing lifestyle in a research study entitled "Usage Prediction of Appliances in Filipino Households Using Bayesian Algorithm" conducted by Pastorfide et al. The data logging using a power meter was conducted for the activation of the appliances, the users, and the occupancy of the household [7].

According to YT Chen's 2017 study, "The Factors Affecting Electricity Consumption and the Consumption Characteristics in the Residential Sector—A Case Example of Taiwan," the use of air conditioners or other cooling devices accounts for 26.81% of all electricity used in households, aside from lighting, which uses 1470 kWh per household. Similarly, refrigerators and rice cookers consume 815.83 kWh (14.88%) and 343.85 kWh (6.27%), respectively. As depicted in Figure 2, household power usage is divided into five categories: air conditioning, lighting, cooking, recreation, and cleaning.

Recreational appliances, which account for 466 kWh or 8% of all domestic electricity demand, include televisions, laptops, audio equipment, and other entertainment devices [8].

As shown in Figure 2, the average standby power of the entertainment devices was measured from 4 Watts to more than 10 Watts. The ICT equipment standby power range from less than 2 Watts to 5 Watts higher and other kitchen appliances was as high as 25 Watts [9].

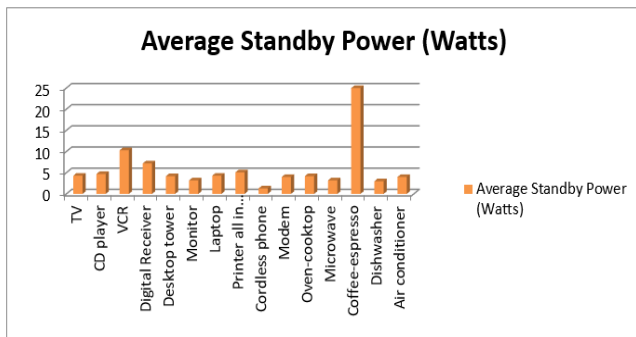


Fig.2. Average Standby Power Consumption

## II. METHODOLOGY

The study used a quantitative-descriptive research method for the collection and analysis of the data. In the conceptual framework of the study, as described in Figure 3, data collection through a survey and measurement of standby power consumption were conducted. Based on the survey, the common electronic appliances in the household were identified. Also, the standby power consumption of these appliances was measured and calculated for the energy assessment.

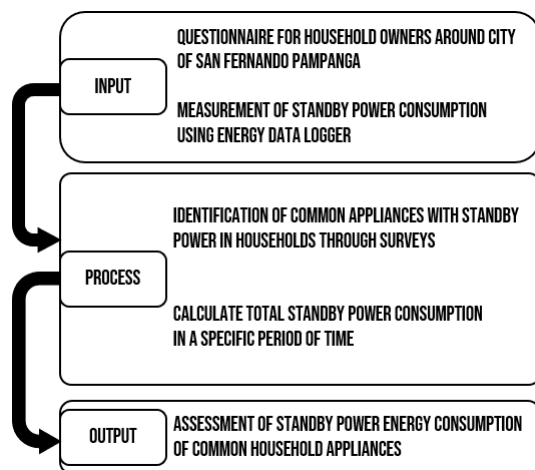


Fig.3. Conceptual Framework of the study

### 2.1 Data Collection and Research Instrument

For data gathering, a survey questionnaire was devised to identify the electronic appliances commonly used in the household, their operating time, and if they were unplugging them after use. In reference to the data needed in the study, the instrument was verified and validated by an expert.

There were fifty (50) residents randomly selected from the different households in the city of San Fernando, Pampanga, Philippines. The survey was conducted using a Google Form questionnaire that was responded to by the participants.

### 2.2 Measurement of Standby Power Consumption

In measuring the standby power consumption of these appliances, a digital energy logger was utilized. Three (3) electronic appliances commonly used at home were identified based on the survey results. The average value was used to calculate the standby power consumption based on the average power during operation and standby mode of each appliance.

$$OP (W) = \text{consumption } (W) \text{ per hour } \times \text{operating hours } (on)$$

$$SMP (W) = \text{consumption } (W) \text{ per hour } \times \text{standby hours } (off)$$

### 2.3 Determine monthly standby power consumption

The measured data were analyzed and calculated for the assessment of the standby power consumption of electronic appliances in their household.

$$SMP (W) = SMP (Wh) \text{ per day } \times 30 \text{ days per month}$$

$$\% \text{Energy Savings} = \frac{SMP (W)}{[OP (W) + SMP (W)]} \times 100$$

## III. RESULTS AND DISCUSSIONS

Common electronic appliances used in the households were classified based on result of the survey conducted from the fifty (50) participants.

### 3.1 Common Household Electronic Appliances

The ten (10) electronic appliances shown in Table 1 were commonly used in the households, along with the measurements of standby energy consumption of each

household electronic device, with the microwave oven being the one with the highest consumption.

Table.1. Common Household Electronic Appliances

Common Household Electronic Appliances	Digital Energy Logger (W)	
	ON	Standby
LCD Television	87.4	0.5
LED Television	69	0.4
TV/Cable Box	6.9	0.1
PC Desktop	119.6	3.5
Router/Modem	6.9	0.1
Printer	13.8	1.5
Laptop	85.1	2.1
Mobile phone	20.7	0.1
Microwave Oven	1000	3
Washing Machine	500	1

The standby power consumption of the frequently used appliances was plotted in a bar graph form (Figure 4) showing that during standby mode these appliances continuously consume electricity. Standby power consumption measured ranges from 0.1 W to 3 W.

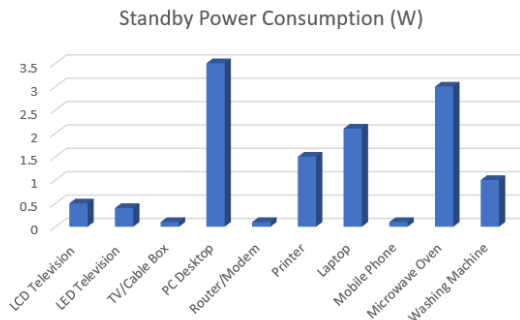


Fig.4. Standby power consumption of Common Household Electronic Appliances

### 3.2 Power Consumption of Household Appliances

Table.2. Power Consumption of the Three (3) Common Household Electronic Appliances

Common Household Electronic Appliances	Digital Energy Logger (W)		Time (Hours)	
	ON	Standby	ON	Standby
LED Television	69	0.4	7	17
Laptop	85.1	2.1	10	14
Microwave oven	1000	3	3	21

In table 2 above, narrowed the common household appliances into the three most common appliances: the LED television,

laptop, and microwave oven. The table also shows the data from the digital energy logger, with the ON or standby status being listed as hours in a day.

#### Power consumption of LED Television (24 hours)

$$\text{OP (Wh)} = \text{consumption (W)} \times \text{operating hours (on)}$$

$$= 69 \text{ W} \times 7 \text{ hours} = 483 \text{ Watt-hours}$$

$$\text{SMP (Wh)} = \text{consumption (W)} \text{ per hour} \times \text{standby hours (off)}$$

$$= 0.4 \text{ W} \times 17 \text{ hours} = 6.8 \text{ Watt-hours}$$

#### Power consumption of Laptop (24 hours)

$$\text{OP (W)} = \text{consumption (W)} \times \text{operating hours (on)}$$

$$= 85.1 \text{ W} \times 10 \text{ hours} = 851 \text{ Wh}$$

$$\text{SMP (W)} = \text{consumption (W)} \text{ per hour} \times \text{standby hours (off)}$$

$$= 2.1 \text{ W} \times 14 \text{ hours} = 29.4 \text{ Wh}$$

#### Power consumption of Microwave oven (24 hours)

$$\text{OP (W)} = \text{consumption (W)} \times \text{operating hours (on)}$$

$$= 1000 \text{ W} \times 3 \text{ hours} = 3000 \text{ Wh}$$

$$\text{SMP (W)} = \text{consumption (W)} \text{ per hour} \times \text{standby hours (off)}$$

$$= 3 \text{ W} \times 21 \text{ hours} = 63 \text{ Wh}$$

### 3.3 Calculated monthly standby power consumption

#### LED Television monthly standby power consumption:

$$\text{SMP (Wh)} = 6.8 \text{ Wh per day} \times 30 \text{ days per month} = 204 \text{ Wh}$$

$$\% \text{Energy Savings} = 204 \text{ Wh} / (14490 + 204) \times 100 = 1.39\%$$

#### Laptop monthly standby power consumption:

$$\text{SMP (Wh)} = 29.4 \text{ Wh per day} \times 30 \text{ days per month} = 882 \text{ Wh}$$

$$\% \text{Energy Savings} = 882 \text{ Wh} / (25530 + 882) \times 100 = 3.34\%$$

#### Microwave oven monthly standby power consumption:

$$\text{SMP (Wh)} = 63 \text{ Wh per day} \times 30 \text{ days per month} = 1890 \text{ Wh}$$

$$\% \text{Energy Savings} = 1890 \text{ Wh} / (90000 + 1890) \times 100 = 2.05\%$$

Table.3. Monthly Power Consumption and Energy Savings

Common Household Electronic Appliances	Monthly Power Consumption (Wh)		Monthly Energy Savings (%)
	ON (OP)	Standby (SMP)	
LED Television	14,490	204	1.39
Laptop	25,530	882	3.34
Microwave oven	90,000	1,890	2.05

Calculated estimation of power consumption monthly in Table 3, with the previous table serving as a reference, showing the total amount of power consumed in ON and standby states in a month. Also, the monthly energy savings were highlighted when none of these appliances were left in standby mode.

#### IV. CONCLUSIONS

Based on the results of the study conducted, the common electronic appliances used in households were identified. Using a digital energy logger, the measured power consumption of these appliances apparently shows that the standby power consumption ranges from 0.1 W to 3 W. These values are comparatively small but become significant in the monthly or yearly energy savings up to 3.34% as calculated from the selected electronic appliances. Thus, the study on energy assessment of standby power consumption can provide insights and opportunities for reducing residential electricity demand.

#### **RECOMMENDATIONS:**

In future research studies, to address standby power concerns with electronic appliances, consumer awareness should be increased by implementing better standby power consumption information to make residents more conscious of the power consumed by these plugged-in appliances when not in use. Additionally, manufacturers of electronic appliances should take the lead in spreading awareness of the energy wasted in standby power through their product labels.

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