



The Intensity of Energy Consumption by Electrical Household Devices in the Pisma Asri Housing Complex, Indonesia

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ABSTRACT

The basic cost of electricity, especially in Indonesian households, has increased in recent years, reaching Rp. 1,467.28 per kilo Watt h in the present day. In this study, we will analyze the electricity consumption of households by calculating the intensity of energy consumption. The average electricity usage in the households of 22 respondents in the Pisma Asri housing complex, Indonesia, ranged from 250 to 450 kilo Watt h, at an average monthly cost of approximately Rp 250,000-600,000. The average electricity intensity (2-5 kilo Watt h/m²) was below 10 kilo Watt h/m², within reasonable limits. Air conditioners had the highest electricity consumption, accounting for 31% of the average electricity usage, followed by refrigerator and lighting bulbs, which accounted for 26% and 14% of the electricity usage, respectively. From these results, we recommend some measures with which households can reduce their energy consumption and be relieved from some of the burdensome costs imposed by electricity supply companies.

Keywords: Electricity Rates, Household Electricity Consumption, Electricity Consumption Intensity

JEL Classifications: O310, O320

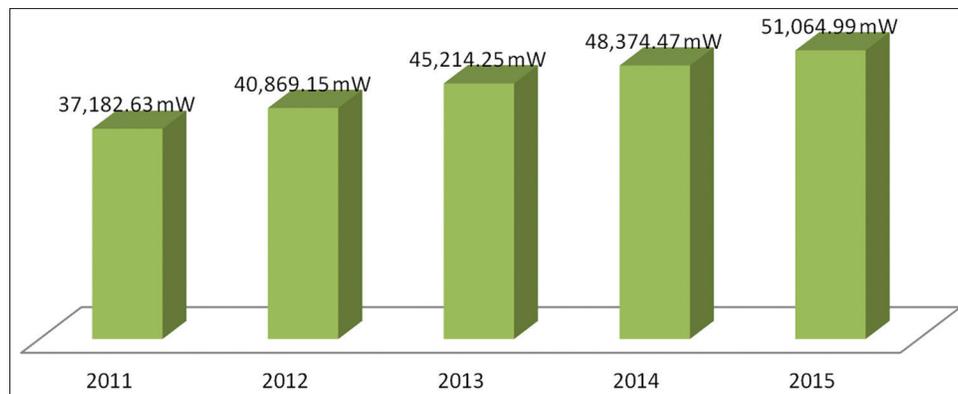
1. INTRODUCTION

In recent years, the electricity consumption in Indonesia has risen rapidly (Akhmad, 2018). This rise has accompanied the country's growing economic growth and increasing population due to improvements in the standard of community life and the increasing number and affordability of electricity sources. When broken down by sector, the largest consumers of connected electrical power are households. According to Electricity Unit Statistics (2015), the usage of connected power in Indonesia reached 37,182.63 mega Watt in 2011 years, 40,869.15 mega Watt in 2012 years, 45,214.25 mega Watt in 2013 years, 48,374.47 mega Watt in 2014 years, and 51,064.99 mega Watt in 2015 years (Figure 1).

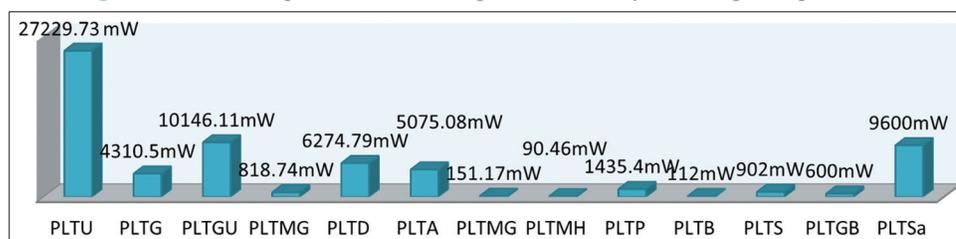
As Indonesia's population increases, this trend is projected to continue, and hence the installed annual capacity of national power generation will increase accordingly. The installed annual capacity

of national power generation was 39,898.97 mega Watt in 2011 year, 45,253.47 Mega Watt in 2012 year, 50,898.51 mega Watt in 2013 year, 53,065.50 mega Watt in 2014 year, and 55,528.10 mega Watt in 2015 year. However, the use of solar power plants by electricity supply facilities remains very low reaching only 9.02 mega Watt in 2015 year.

The housing sector consumes a large share of the total energy resources (Sukarno et al., 2015). In order to reduce this energy consumption, Sukarno et al. (2015) suggested the installation of efficient household appliances, adopting community behaviors that save electricity, and labeling the energy consumption efficiency of household appliances. According to Kama and Kaplan (2013), the Turkish Government is already currently improving its energy efficiency policies by labeling the efficiencies of electrical equipment. Santamouris (2011) conducted an energy audit in a Prof.H.B Saanin Padang hospital and estimated its energy saving. Danang (2000) suggested that sugar factories PT Jatiroto PTPN XI Surabaya can save electricity by installing a Genset

Figure 1: Connected electricity power in Indonesia

Source: Electricity Units Statistics, 2015

Figure 2: Installed capacities of different power sources by national power plants in Indonesia

Source: Electricity Statistics, 2015

diesel generator. Mc Narry and Mayclin (2012) reported that although the total energy consumption per household is relatively constant, the use of electrical energy is increasing. Indonesia's state electricity company (Perusahaan Listrik Negara, abbreviated as PLN) is a state-owned company that raising the tariff cannot really be called an "improvement" as it compromises the lifestyles of those who cannot afford it raising the basic electricity tariff. In its efforts to conserve electricity, the PLN is currently implementing energy-conservation programs and conducting energy audits.

Erwin (2008) suggested that conservation energy is an efficient and rational energy source that does not disturb other energy resources. Meanwhile, energy audits can identify potential energy saving in both facilities and systems. Therefore, energy audits can guide the implementation of energy conservation.

The present government policies (i.e., raising the household basic electricity tariff, especially that of the R-1 (House Type-1) group run by 900 VA-RTM (Volt Ampere Rumah Tangga Mampu) power is burden some to the community (Figure 2). The tariff was raised in a stepwise fashion, reaching Rp. 791.00 per kilowatt h in January/February 2017 (first step), Rp. 1034.00 per kWh in March/April 2017 (second step), and Rp. 1352.00 per kWh in May/June 2017 (third step). In July 2017, the cost was Rp. 1467.28 per kWh (source: Minister of Energy and Mineral Resources Regulation No. 31 of 2014 on Tariff Adjustment) (Figure 3).

Electricity/energy that must be released by Universitas Pendidikan Indonesia in operating all Air Conditioning units per month is 76,930,672 kWh / month for 257 units, a maximum of 8 working hours. The amount of funds for the electricity/power

consumption costs incurred by UPI to operate all AC units for 8 hours/day is: Rp. 25,002,468.4, - / month and for 2 hours/day Rp. 6,255,492.1, - / month (Hasan, 2010).

The efficiency of electrical energy consumption in the JICA FPMIPA building at the Indonesian University of Education can be improved by replacing dead lights at a number of points of light and installing active and passive filters on non-linear electronics so that the total harmonic current (THD I) can be reduced (Mulyadi and Mulyadi, 2013).

This energy audit will be carried out at a gas power plant. Gas power plants consist of compressors, combustion chambers and turbines. The performance of this generator is indicated by the value of thermal efficiency. During the process, there are definitely losses that cause the performance of the plant to decrease (Wilhansen, 2017).

2. METHODS

We adopted in this research a quantitative and a qualitative methodology. The quantitative data included the building area, the cost of electricity usage, and the amount of electricity used in each room. The qualitative data were the building or building specification data. The research was carried out in five stages: (1) Identifying the household objects using R-1 (House Type-1) class electricity with 900 VA-RTM (Volt Ampere Rumah Tangga Mampu) power; (2) counting the number of electricity-powered devices and calculating their energy consumption; (3) calculating the monthly energy needs of each household; (4) calculating the electricity costs; and (5) identifying the

electrical equipment that can reduce the electricity costs payable to the PLN. Flowchart 1 shows a flowchart of the research.

3. RESULTS AND DISCUSSION

Figure 3: Electricity tariff rises panic residents



Source: Documentation of Radar Tegal newspaper, May 30, 2017

3.1. Determination of the Research Objects

This subject of this study was the Pisma Asri housing complex that is located on Jalan Segarawana II, West Mejasem, Tegal Regency, Central Java Indonesia (Figure 4), where the power usage of approximately 40 households ranges from 2200 VA -RTM (Volt Ampere Rumah Tangga Mampu) to R-1 (House Type-1) 900VA-RTM (Volt Ampere Rumah Tangga Mampu). The study subjects were families using Gol R-1 900VA-RTM (Volt Ampere Rumah Tangga Mampu) power.

3.2. Average and Intensity of Electric Energy Consumption

After viewing the inventory data of the electrical equipment in the dwelling of each respondent, we obtained the average monthly electrical energy usage of the residents of the Pisma Asri Housing Complex and calculated the electricity consumption intensity as the quotient of the energy consumption and the land area (kWh/m²).

Flowchart 1: Research flowchart

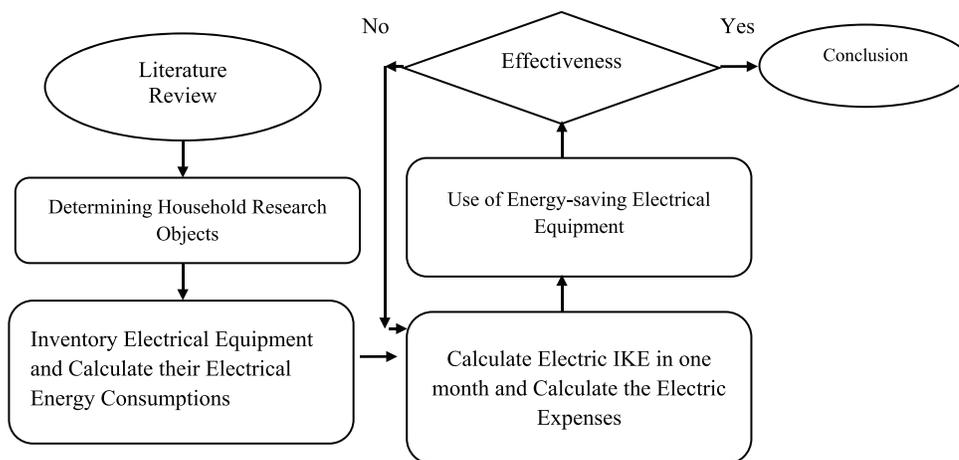


Figure 4: Shows an overhead of the Pisma Asri housing complex

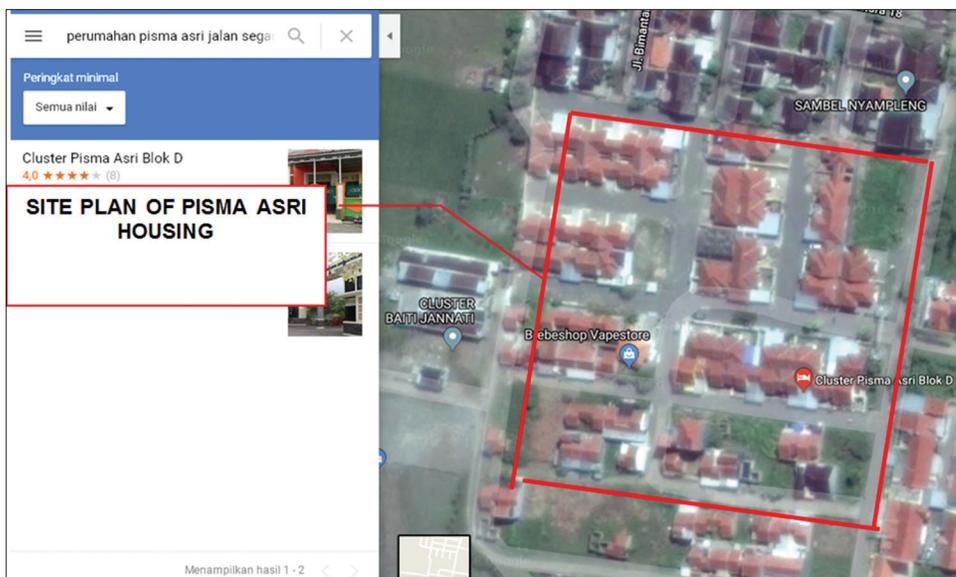


Figure 5: Monthly consumption of electrical energy in the households of the 22 respondents (kWh)

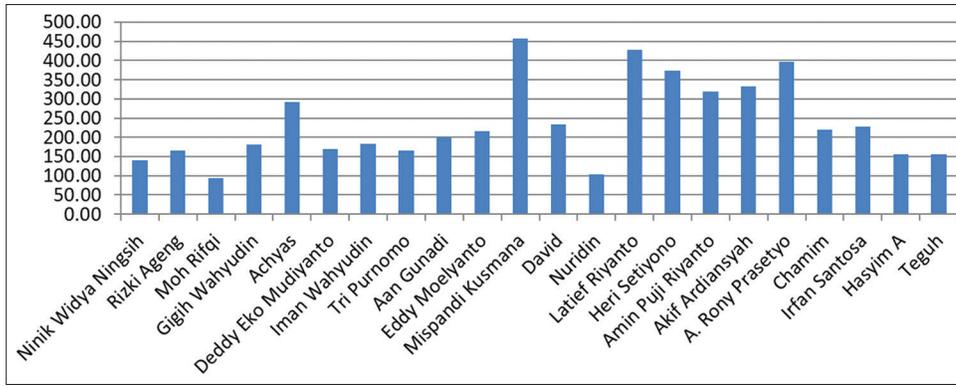


Figure 6: Monthly electricity costs of the 22 respondents

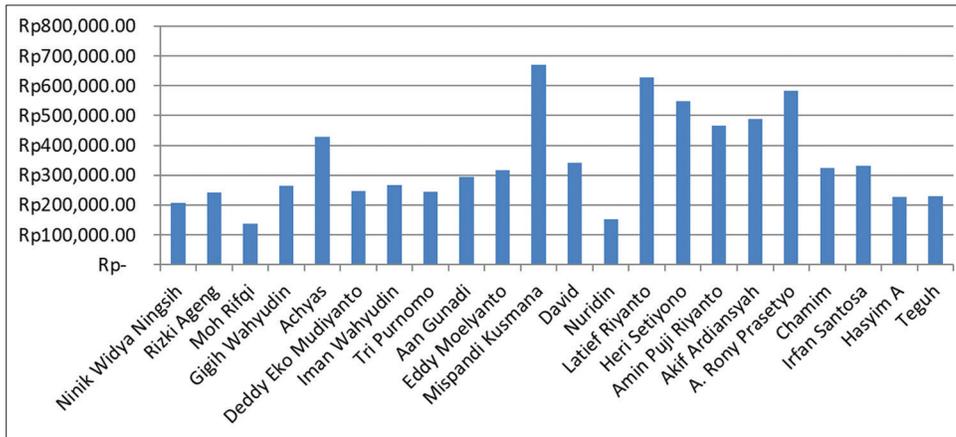


Figure 7: Electrical energy consumption intensities of the 22 respondents

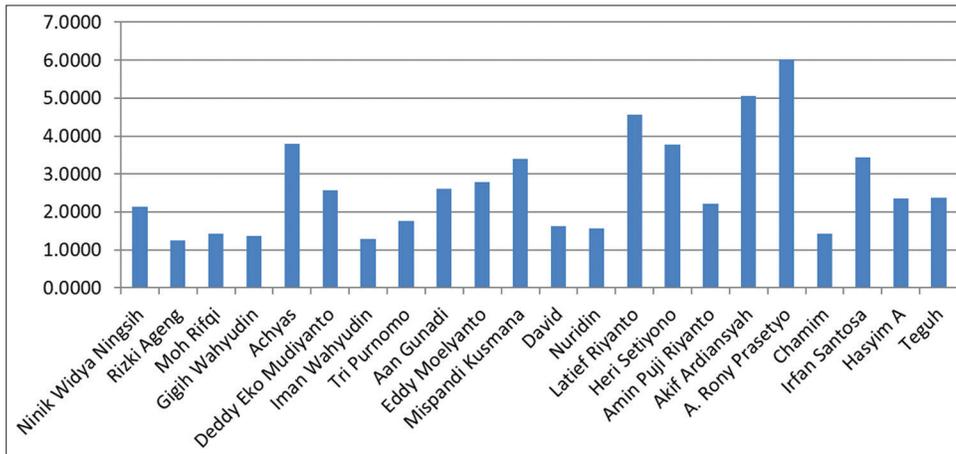


Figure 5 graphs the average electrical energy used monthly in the respondents' households. The average monthly usage of the residents of the Pisma Asri Housing Complex ranged from 100 to 300 kWh, although a few households consumed 300-450 kWh. The residents that consumed the highest electricity amounts were found to occupy land areas exceeding 100 m². They also used a large number of light sources and electrical devices. In general, the consumption of electrical energy affects the electricity load and raises the monthly costs payable to the PLN. Figure 6 shows the costs paid by the 22 respondents in the present study.

On average, the electricity costs of the residents the Pisma Asri Housing Complex ranged from Rp. 100,000.00 to Rp. 300,000.00; the costs of some residents, however, approached Rp. 700,000.00. When the PLN raised the electricity costs to Rp. 1,467.28 per kWh, the residents of the Pisma Asri Housing Complex were not significantly affected because almost 50% of them already pay (on average)Rp. 300,000.00 per month to the PLN. Nevertheless, the energy consumption intensities (Intensitas Konsumsi Energi/IKE) of all respondents remained within reasonable limits (below 10 kWh/m²).

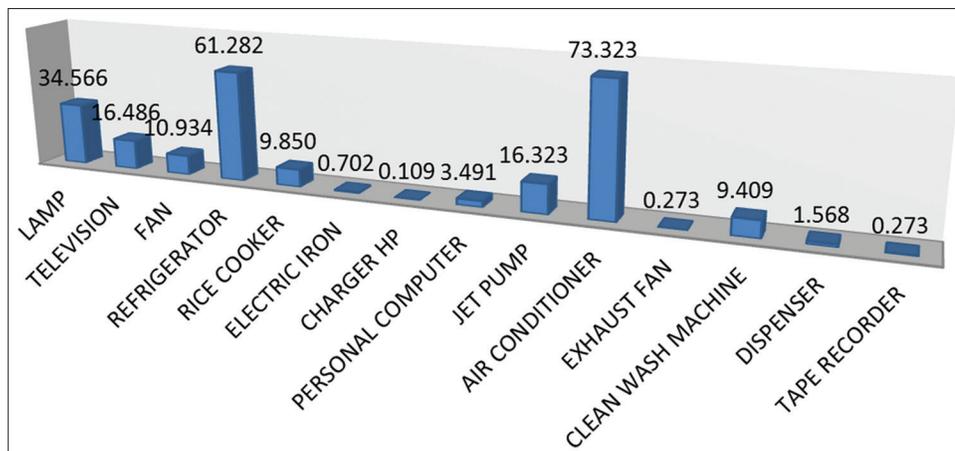
Figure 8: Average electricity consumption of electrical household devices in kWh

Figure 7 graphs the electrical energy consumption intensities (IKE) of the 22 respondents in Pisma Asri Housing Complex. The IKE specifies the amount of electrical energy consumed per building/land area. Theoretically, this ratio illustrates the proportionality between the electrical energy usage and the building area: The more extensive the building is, the higher the electrical energy consumption is. In practice, however, the IKE depends also on the shape of the building. In narrow building areas, the electrical energy can be proportionally large and the IKE values can increase.

Figure 8 compares the average electricity consumption of various electrical devices used at homes in Pisma Asri Housing Complex. Air conditioners had the highest electricity consumption, accounting for 31% of the typical usage. Although typically turned on for only 8 h per day (during the sleeping hours), air conditioners operate at approximately 350-400 Watt. Refrigerators are another device with high power consumption, accounting for approximately 26% of the total energy used. They require approximately 70 Watt of power, but they must operate 24h daily to store perishable foods and drinks. The burning of 15-50Watt incandescent lamps for approximately 8-10h accounts for around 14% of the monthly usage. Although some of the respondents have already install led low-wattage lights, lights must be adjusted to meet the needs of every specific room, which may require more installations. The use of other electrical equipment, such as televisions, jet pumps, and fans, collectively accounts for <10% of the total monthly usage. The use of electrical equipment remains low because most of the respondents are employees who are mainly active in the mornings and evenings. Typical television usage ranges from 3 to 4 h.

4. CONCLUSIONS

In this 1st year of our research, we determined the specifications of electrical household equipment and the number of electrical devices at the home of each respondent. The electricity consumption needs of the households were based on their electrical equipment usages per month. By knowing the electrical equipment and how it is used, we can enact energy saving. The main conclusions of this study are summarized below:

1. Among the typical household devices, the device with the highest energy consumption was the air conditioner

(accounting for 31% of the total usage), followed by refrigerators and lighting (accounting for 26% and 14% of the total usage, respectively).

2. The average electricity consumption per month of the respondents in the Pisma Asri Housing Complex, Indonesia, is below 500kWh. Their electricity consumption intensity is within reasonable limits (below 10kWh/m²).

As an early energy-saving step, the timers installed on the remote controls of air-conditioning units can be set to turn off when the residents area sleep and the room temperature has reached the desired value. In order to reduce the energy consumption of refrigerators, the residents should not set the refrigerator's temperature control to the coolest setting. Finally, the energy consumption of incandescent lamps can be reduced by turning off the unused or unrequired lights.

5. ACKNOWLEDGMENTS

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REFERENCES

- Abdurarachim, H.P., Ari, D., dan Sulaiman, T.A. (2002), Audit Energi, Modul 2, Energi Conservation Efficiency and Cost Saving Course. Bandung: PT. Fiqry Jaya Mandiri.
- Akhmad, A. (2018), Study of fuel oil supply and consumption in Indonesian. *International Journal of Energy Economics and Policy*, 8(4), 13-20.
- Prosedur Audit Energi Pada Bangunan Gedung. Badan Standardisasi Nasional. Available from: <http://www.bsn.go.id>.
- Danang, P. (2000), Audit dan Konservasi Energi pada Pabrik Gula Jatiroto-PTPN XI. Jatiroto: PTPN XI.
- Effendi, A., Miftahul J. (2016), Evaluasi intensitas konsumsi energi listrik melalui audit awal energi listrik di RSJ Prof HB. Saanin Padang. *Jurnal Teknik Elektro Institut Teknologi Padang*, 5(2).
- Hasan, S. (2010), Audit Energi untuk Pemakaian Air Conditioning (AC) pada Gedung Perkantoran dan Ruang Kuliah di UPI. Bandung: Universitas Pendidikan Indonesia.
- Kama, O., Kaplan, Z. (2013), Energy efficiency polities in Turkey: The case for standards and labels. *International Journal of Energy*

- Economics Dan Policy, 3, 62-73.
- Mc Narry, B., Mayclin, D. (2012), How Are We Using Energy in Homes Today? Results from the 2009 Residential Energy Consumption Energy (RECS). United States: U.S. Energy Information Administration.
- Mulyadi, Y., Rizki, A. (2013), Analisis audit energi untuk pencapaian efisiensi penggunaan energi di gedung FP MIPA JICA Universitas Pendidikan Indonesia. Jurnal Electran, 12(1), 81-88.
- Santamouris, M. (2011), Energi Performance and Energy Cosestration in Health Care Building in Hellas. Jakarta: Depdiknas.
- Sukarno, I., Matsumoto, H., Susanti, L. (2015), Urban energy consumption in a city of Indonesian: General overview. International Journal of Energy Economics and Policy, 5(1), 360-373.
- Wilhansen, S.K. (2017), Audit Energi pada PT Indonesia Power UBP Pesanggrahan Unit 3 Denpasar-Bali. Surabaya: ITS Paper 19759-2107100055.