Electricity consumption profile of mid income-housing

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Abstract. The building sector has a significant contribution to global warming and climate change with respect to the energy consumption. In order to reduce greenhouse gas (GHG) emissions, buildings must strive to immediately reduce energy consumption using fossil fuels. Today's urban housing consume quite high energy. The need for modern urban life and increasingly narrow land conditions, urban heat island conditions, dense urban environments contribute indirectly to changes in urban housing conditions. This study aims to examine the profile electricity energy of homes in urban areas. This study processes data from questionnaires. The result indicates the use of electrical energy is quite frequent for cooling the building in the night with setting temperature far below the comfort standard, considered a waste of energy.

Keywords: energy consumption, urban housing, tropics

1. Introduction

Year of 2019 was recorded as the second warmest year and the end of the warmest decade (2010-2019) [1]. CO₂ which causes the greenhouse effect leading to increased global warming reach the new level on 2019. Based on international data, buildings contribute as much as one third of total greenhouse gas emissions, a significant contributor to global warming and climate change today, in addition to the transportation and industrial sectors. The building sector in urban areas has an important factor in contributing to CO₂ emissions through the use of fossil energy. Global CO₂ emissions are driven by strong population growth; it is estimated that 1.2 billion Asians will migrate to the cities over the next 35 years [2]. This household energy consumption increases in line with the increase in household income [3-5].

In the case of Indonesia, national energy consumption reached 1.23 billion barrels’ oil equivalent (BOE) in 2017. Based on data from the Ministry of Energy and Mineral Resources, of this number 382.95 million BOE or nearly a third of energy consumption for the household sector and is the largest compared to other sectors. This portion of energy consumption in the household sector reached 15% of the total final energy consumption in 2015 [6]. The potential for savings that can be made from the household sector is quite large. PT Perusahaan Listrik Negara (PLN) recorded that electricity consumption during the first quarter of 2019 reached 78.18 Terawatt hour (TWh). The household sector is recorded as a consumer with electricity consumption holding a share of 48.85%. Followed by the industrial sector as much as 32.44% [7]. Currently, most of the electrical energy in Indonesia is...
supplied by fossil power plants. This is promising that reducing electrical energy in the home sector can reduce gas emissions.

This study aims to examine the profile of electricity consumption of houses in urban areas related to energy use. This study refers to the profile of housing resident behaviour. The purpose of this study is to obtain occupant profiles regarding electricity usage. Understanding the profile of household energy consumption it is expected can be improved to reduce energy consumption.

Energy-efficient house is expected to reduce the level of electrical energy consumption, in this case energy from fossils, that it the end can reduce the level of carbon gas emissions that cause climate change. Knowing the profile of energy use in the house is expected to be able to find out the causes of large energy use in household consumers related to architecture so that architects can anticipate in their designs.

2. Method

The data are obtained from a questioner surveys with respondent mostly from Jakarta city surrounding area. Regarding energy, the data collected is data on home energy use in urban areas. Respondents are classified as a middle income housing resident. This purposive respondent obtained from university student family. The data generated from 65 respondents of the Bina Nusantara University students. Typical family who can afford their children attend to the best universities.

3. Result and Discussion

Serve for all community, in general, household electrical power is divided into 3 groups, namely R1, R2, R3 with different price schemes [8]. The lowest price is R1/TR group with power limit of 450 VA and the highest is R3/TR with power limit more than 5,500 VA. 450 VA group is a power group intended for low incomes customer that receives subsidized electricity prices. This price is 10 times lower than the price of the highest power group.

The survey obtained 65 respondents' data, mostly resident of the urban community. Respondents are consumers with electric power above 900 VA, it is confirming the purpose of this targeted study for mid-income housing. Figure 1 shows the respondents mostly can be categorized as mid-upper economic society, indicated by customer using the electricity power above 900 VA, and even 50% respondent are above 4400 VA.

Respondents are families with university student age, indicates they are a generation X family who the parents were born in 1960 – 1980. 80% respondents live in urban areas of the Jakarta metropolitan area, and 20% live in others. Metropolitan area, is an urban city that surrounds of Jakarta, Bogor, Depok, Tangerang and Bekasi. 90% respondents live in a house with the area more than > 50 m². The most live in 100m² house (24.6%), 12.3% live at 60m² and 10.8% live at 80 m². Electricity bills paid by customers can provide an overview of the electricity usage used by these families. 47.7% respondents spent Rp. 1,000,000,00 - for monthly electricity bills that equal approx. 750 kWh/month, 16.9% spent Rp. 600,000,00 –Rp. 800,000,00 equal to 500 kWh/month and 15.4% spent Rp. 400,000,00 approx. 300 kWh/month.

Based on the results of the study, it shows that 90% mid income housing respondent use air conditioning (AC) as electrical equipment in their house, another 10% responses can be interpreted as not being answered by the student, because it is not directly related to their experience. The use of air conditioning seems to have become an urgent part of household appliances. It even seems that it has become an integral part of the house in the middle and upper income community (Figure 2).

The use of air conditioning diagram (Figure 3 and Figure 4) indicates that most of the residents (100%) of the house use AC for their bedrooms in night and 50% need cooling for the living room also. This is quite understandable, while during the day most of the residents have activities outside the home, houses to be inhabited at night. Uncomfortable thermal conditions of the room were the main causes of using AC in the room. This shows that almost all residential houses have not met the thermal comfort conditions expected by residents. All respondent utilize AC for cooling the room, even at night there is absence of solar radiation (Figure 4). This implies that the condition of the
bedroom in the dwelling does not provide enough thermal comfort for the occupants. It is confirmed in Figure 5, 70.8% respondent explained the reason for using AC at night because at night, it was hot.

This study implied AC serve during the night also which the temperature is in minimal condition. Figure 6 shows based on the annual climate data in Indonesia, the average temperature during the day ranges from 30-32 °C with the lowest temperature 30 °C on January and the highest temperature as 33 °C in September as the warmest month. At night, the average lowest temperature ranges from 23 °C to 24 °C and the lowest temperature on August [9].

The study of thermal comfort interprets; night is a time when temperature probably is felt comfort. This should not require the building's active cooling equipment such air conditioner (AC). This condition identifies that most of the dwellings / houses have not been able to provide the expected thermal comfort for this mid income housing. This also indicates that the bedroom does not meet the comfort conditions expected, even at night, the average air temperature is in the range 24-27 °C as shown in Figure 7. The built environment factor changes the conditions into uncomfortable living conditions. Their house that is currently occupied has not reached the condition of thermal comfort.
The standard of thermal comfort in Indonesia is based on American standards (ANSI/ASHRAE 55-1992) [10] recommends a comfortable temperature of 22.5 - 26 °C. Meanwhile, thermal comfort research conducted by Karyono [11] stated that employees working in Jakarta feel comfortable at 26.4°C. Warm humid night-time temperatures ranging from 24 - 25 °C which is a temperature that is quite comfortable for tropical residents. In this case, about 50% respondent set the AC temperature at 18 °C (Figure 8). These middle-income home residents prefer to feel lower comfort at a set temperature of 18 °C as the room temperature, compared to the average standard comfortable temperature, which is a worker in an office. Actually, 18 °C is quite cool as room temperature, compared to the average temperature felt by residents in humid tropical climates. The large difference between the thermal comfort conditions and the occupants' behaviour indicates a significant waste of electrical energy. There is a temperature difference of 8 degrees between the standard comfortable temperature and the AC setting temperature. The 75% of residents in medium-sized homes can save electrical energy for air conditioning by setting a comfortable temperature of 24 °C or 55% of residents if setting it at a lower standard temperature as 22 °C.

4. Result and Discussion
The use of electrical energy in the household sector can be classified as customers with small (R1), medium (R2) and large power (R3) users which also shows the economic level of the occupants of the house. From these study, almost all of the resident use air conditioning (AC) in the house, especially in their bedroom. Air conditioning (AC) is used mostly at night (80%) in the bedroom (100%), which indicates that the bedroom in the mid income housing have not provide thermal comfort by using
passive/natural cooling. The use of electrical energy is quite frequent for cooling the building and the majority of residents choose a temperature of 18 °C as a temperature set point indicates use of a considerable waste of energy.

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