



# Characteristics and determinants by electricity consumption level of households in Korea

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## ABSTRACT

This study divides the households into five groups according to the electricity consumption and compares the characteristics and the determinants of household electricity consumption for only two groups, the lowest and the highest. The data are drawn from a household energy consumption sample survey by Korea Energy Economics Institute in 2015. The results show the differences in socio-demographic, dwelling, and electricity consumption characteristics between two groups. Next, the factors affecting the household electricity consumption are investigated. Factor affecting the household electricity consumption for two groups is only the number of electrical appliances. There are also the differences in major determinants of the household electricity consumption for two groups. The results of this study would be useful for understanding socio-demographic, dwelling, and electricity consumption characteristics for two groups.

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## 1. Introduction

Currently, six tariff systems are used for electricity pricing in Korea. These systems were prepared for electricity rates according to the type of electricity consumption for various facility purposes, including residential, general, educational, industrial, agricultural, and street lighting usage (Kim, 2014). For general, industrial, and educational facilities, rates differentiated by seasons and time zones are applied to electricity consumption to encourage the reasonable usage of energy through demand-side management. The rates differentiated by season are generally more expensive in the summer and winter while those differentiated by timezone are typically higher during hours of intense electricity demands during the day. For residential facilities, progressive rate system is applied according to electricity consumption volume. The last one is street-light with a single tariff system. Power consumption patterns for general and industrial facilities will be different according to the types of workplaces (Kim, 2017). On the other hand, electricity consumption patterns for residential facilities will not be significantly different. However, electricity consumption levels for residential facilities will be different according to several factors affecting the electricity consumption. For examples, electricity consumption levels for residential facilities are expected to be influenced by socio-demographic, dwelling characteristics and external factors such as climate and the energy use charges. Until now, several studies have been done that household electricity consumption is largely affected by demographic characteristics such as member

of household and household income (Korea Energy Economics Institute, 2015). However, most studies have been designed for overall households (Noh and Lee, 2013; No, 2014). This study examines the characteristics and the determinants of household electricity consumption for only two groups, the lowest and the highest households. Especially, this study compares how different socio-demographic, dwelling, and electricity consumption characteristics of the lowest and the highest households are. Most previous research summarizes electricity consumption according to demographic characteristics of household and analyzes determinants of household electricity consumption, which are generally for whole households. We first divide households into quintiles using annual average electricity consumption volume and examine socio-demographic, dwelling, and electricity consumption characteristics of the lowest and the highest households. Next, we compare the differences in major determinants of the household electricity consumption for two household groups. This study is meaningful in that it compares and analyzes the characteristics and the factors affecting power consumption for two groups.

## 2. Theoretical background

The electricity tariff system for residential usage (Kim, 2014) was three-stage tariff system that reduced tariffs if the usage amount was high until the year 1972 and was converted into a single tariff system in 1973. However, a three-stage progressive rate system was introduced for the purpose of saving energy consumption and protecting the low-income class due to the surge in energy prices while experiencing the first oil shock in December

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**Table 1**

Major changes in electricity pricing structure for residential service (Shin, 1989; Yoon, 2011).

Year	Progressive levels	Progressive rates	Comments
~ 1973	Single level		
1974	Three-stage	1.6 times	1st oil crisis
1979	Twelve-stage	19.7 times	2nd oil crisis
1988	Four-stage	4.2 times	
1996	Seven-stage	13.2 times	High oil prices
2000	Seven-stage	18.5 times	
2004	Six-stage	11.7 times	
2016	Three-stage	3 times	

1974. Since then, it has continued to change the progressive levels and progressive rates depending on international crude oil price and power supply program. A six-stage progressive rate system was continuously applied from 2004 to 2016, and a three-stage was mitigated from the six-stage in December 2016. The mitigated structure was divided into three stages: indispensable interval of 0 to 200 kWh (first-stage), average interval of 201 to 400 kWh (second-stage), high consuming interval of over 401 kWh (third-stage). Rates are applying 93.3 Korean Won for the first-stage, 187.9 Korean Won for the second-stage and 280.6 Korean Won for the third-stage (Korea Electric Power Corporation, 2015b). Table 1 shows the major changes in electricity pricing structure for residential use.

According to the previous six-stage progressive rate system for residential usage shown in Table 2, households using less than 100kWh of monthly electricity consumption in 2015 were 3684000 households, which was 16.7% of the total households. Korea Power Exchange research report (Korea Power Exchange, 2014) revealed that most of the first-stage customers using less than 100kWh were single-person households (42%), non-residential customers (42%) and the proportion of low-income households among the first-stage customers is low. In reality, as the heating cost in winter increases due to high oil prices, low-income and elderly households are more likely to use heating appliances such as electric plates. As a result, those households are increasingly burdened by the progressive rate system and original intention of progressive rate system for income redistribution was weakened (Energytimes, 2016). Lee and Park (2008) analyzed the supporting and electricity saving effect for the low-income households on the progressive rate system. The results showed that the average monthly power consumption of the lowest income households is around 230kWh, which means the lowest income households are not the first-stage customers. In particular, approximately 40% of the households receiving national assistance are not the first-stage customers. However, the energy census conducted by the Korea Energy Economics Institute shows that the electricity consumption per household increases with the increase of the number of households, income, and residence in the city (Korea Energy Economics Institute, 2015). The studies of factors affecting the electricity consumption of households have been done especially in overseas. Factors affecting electricity consumption per household are as follows: economic capacity (Druckman and Jackson, 2008; Cayla et al., 2011), socio-demographic characteristics (Kaza, 2010; Jones et al., 2015), dwelling characteristics (Kavousian et al., 2013), housing location (Druckman and Jackson, 2008), environment and climate characteristics (Kavousian et al., 2013), and energy use charges (Nesbakken, 1999).

The research of determinants affecting the electricity consumption has been carried out by analyzing the whole households. The analysis according to the household characteristics has not been done much. This study compares the characteristics and the determinants of household electricity consumption for the lowest and highest electricity consuming households.

### 3. Research methods

The data are drawn from a household energy consumption sample survey by Korea Energy Economics Institute (2015). The Korea Energy Economics Institute conducted an interview survey of 2,250 households nationwide in order to establish data to identify the electricity consumption of the whole household sector. Electricity consumption by household characteristics, the number of appliances, the average capacity of appliances, and the average usage time of appliances are being investigated since 2008 and are being surveyed every year since 2009. The major survey items of the household energy consumption sample survey for 2015 are the physical characteristics of the dwelling, demographic characteristics, heating and cooling method, household income, monthly electricity consumption, the number of major household appliances, the average capacity of major home appliances, the average usage time of major home appliances, and the number of other home appliances (Korea Energy Economics Institute, 2015). Major home appliances include TV, washing machine, air conditioner, electric fan, refrigerator and rice cooker. In this study, we divide annual electricity consumption into quintiles, and analyze characteristics of the first quintile with the lowest electricity consumption and the fifth quintile with the highest electricity consumption. First, we compare socio-demographic, dwelling, and electricity consumption characteristics of the first and fifth quintiles of electricity consumption. Next, we examine the effect of socio-demographic characteristics and electricity usage behavior on the actual electricity consumption of two groups of households. The methods used in this study are t-test, chi-square test, and multiple regression analysis, and R.3.3.2 is used for statistical analysis.

### 4. Research results

#### 4.1. General characteristics of two household groups

Table 3 summarizes the socio-demographic characteristics of 504 households with the lowest power consumption and 504 households with the highest power consumption among the 2,520 household samples in 2015. From the results in Table 3, the first and fifth quintiles of power consumption show statistically significant differences in all socio-demographic characteristics, except gender and household characteristics. Gender of household head in the first quintile does not significantly differ from that in the fifth quintile. However, Permana et al. (2015) argued that when the decisions about energy expenditure and control of energy consumption in the household were solely made by a woman, energy consumption tended to be the lowest. Few research results that sought to analyze household characteristics-related factors have been reported to date. 20's and 60's in the first quintile are relatively more than those in the fifth quintile. This results are the same as that the level of household electricity consumption of the elderly is far lower than that of people aged 0–59 (Fu et al., 2014). The education level of the first quintile is relatively lower than that of the fifth quintile. There was no difference between the two groups in the occupations of regular workers. However, self-employed workers are relatively more distributed in the fifth quintile and temporary, daily and other workers are relatively more distributed in the first quintile. The average monthly income of the households is relatively high in the fifth quintile, household size in the fifth quintile is large, and the composition in the fifth quintile is more diverse.

Table 4 summarizes the physical characteristics of the dwelling of the first and fifth quintiles of electricity consumption. The results show that there are statistically significant differences in all characteristics except the housing type. The percentage of residents who live in small & medium-size city of the first quintile is relatively higher than that of the fifth quintile, and the proportion of

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