

Residential Electricity Consumption of Seoul

Subjects: Management

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This entry aims to determine the relationship between residential electricity consumption and other factors by analyzing the correlation and multiple regression between residential electricity consumption and three variables which are known as the factors affecting residential electricity consumption.

Keywords: residential electricity consumption ; income ; number of household members ; age ; correlation ; multiple regression analysis

1. Introduction

Currently, six electricity tariff systems are used for electricity pricing in Korea. These systems are 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 ^[1]. Different usages have different prices because supply costs vary according to the conditions of electricity usage such as voltage, load rate, usage time, and customer cost ^[2]. For residential use, a progressive rate system is applied according to electricity consumption volume, unlike rate systems for other purposes. This progressive rate structure of residential usage was introduced in 1974 for the purpose of saving electricity energy consumption and protecting the low-income class due to the surge in energy prices while experiencing the first oil shock in 1973. Since then, the progressive rate structure has been applied until now by changing the progressive stage and the progressive rate according to international oil prices and electricity supply and demand conditions ^[1]. This progressive rate system is done not only in Korea, but also in other countries. By adopting a progressive system for public utility charges that are directly connected to the real life of the people, such as electricity bills and water bills, it aims to curb demand and assist low-income families ^[3].

According to Enerdata ^[4], a European energy consulting firm, Korea's electricity consumption in 2018 totaled 526 TWh, which is the sixth largest in the world. It is pointed out that the use of electricity is relatively higher than the size of the economy and population. The electricity used for residential use totaled 70,687 GWh, a 6.3% increase from the previous year, and recorded the highest level in 25 years since the aggregation of power statistics in 1993 ^[5]. This is attributed to the increased operation of air conditioners due to the extreme heat wave in the summer of 2018 ^[6]. Another reason could be interpreted to be that Korea's residential electricity bill is the third lowest among the Organization for Economic Cooperation and Development (OECD) 33 countries ^[7]. Nevertheless, the temporary progressive system easing measures during the summer period were implemented in response to the extreme heat wave in the summer of 2018, and it is still easing the burden of electricity bills by raising the upper limit of stages during the summer ^[8].

Meanwhile, according to International Energy Agency (IEA) annual report ^[9], global energy consumption in 2018 increased at nearly twice the average rate of growth since 2010. Driven by higher energy demand in 2018, global energy-related carbon dioxide (CO₂) emissions rose 1.7% to a historic high of 33.1 Gt CO₂. Korea played a part in increasing carbon emissions, showing an increase in carbon emissions (2.8%), which is seven times higher than the average of OECD member countries ^[10]. In order to reduce carbon emissions, it is necessary to increase the electricity rates produced by coal power generation, increase the proportion of liquefied natural gas (LNG) power generation instead of coal power generation, and actively expand renewable energy. Although the LNG fuel cost has recently dropped significantly, the unit price of LNG power generation is still higher than that of coal power generation ^[11]. In addition, since the generation cost of renewable energy is still expensive ^[12], it can be said that an increase in electricity rates is inevitable until the "grid parity" (when the cost of the alternative energy becomes equal to or less than electricity from conventional energy forms like fossil fuels) is reached.

As such, in a situation where an increase in electricity rates is inevitable due to the rising fuel costs for electricity generation, Korea, which is on the cheaper side of electricity rates in the world, continues to offer discounts on summer electricity rates since the heat wave in 2018. Therefore, in order to check whether the cost per household due to the increase in electricity rates is feasible, we will examine the factors that affect electricity consumption. For this purpose, this

study aims to determine the relationship between residential electricity consumption and other factors by analyzing the correlation and multiple regression between the residential electricity consumption and three variables (income, number of household members, and age), which are known as the factors affecting the residential electricity consumption.

2. Background

The residential electricity bill in Korea is a two-part charge consisting of a basic charge and a power charge ^[1]. The basic charge is a charge for recovering fixed costs and facility investment costs for maintaining facility availability, and is determined in consideration of system simultaneous load rates, type load rates, and usage. The power charge is a charge for recovering the short-term fluctuation rate that varies with the amount of electricity consumption ^[2]. In addition, charges, including a value-added tax (VAT) and a power industry infrastructure fund, are added. The power industry infrastructure fund is a fund created in the process of restructuring the power industry, and is intended to be used in various ways in the power field, but as the name or purpose of the fund reveals, it is being invested in “building the power industry base” ^[13]. Therefore, in order to calculate the electricity bill, the basic charge and the power charge are summed, and then the VAT (10%) and the power industry infrastructure fund (3.7%) are added.

The unit price of the basic charge and the power charge differs depending on the electricity supply method (low voltage, high voltage). The low voltage is used in detached houses, terraced houses, and low-rise apartments, which are the houses without electric power transformers, while the high voltage is used for houses with electric power transformers such as apartments with middle floors or higher. The price of high voltage is cheaper than that of low voltage, but high voltage customers are responsible for the cost of installing electric equipment, such as electric power transformers, and customer management costs, such as the collection of charges ^[14].

The electricity tariff system for residential area was a six-stage 11.7 times rate system from 2004 to 2016, and was eased to a three-stage 3 times rate system in December 2016 ^[15]. 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), and high consuming interval of over 401 kWh (third-stage). In the case of low voltage, rates for the power charge apply KRW 93.3 for the first-stage, KRW 187.9 for the second-stage, and KRW 280.6 for the third-stage ^[14]. The basic charge is also increased to KRW 910, KRW 1600, and KRW 7300 for every 200 kWh according to the usage amount ^[14]. If a household used 460kWh in June, the basic charge is KRW 7300, the power charge is KRW 73,076 (200 kWh × KRW 93.3 + 200 kWh × KRW 187.9 + 60 kWh × KRW 280.6). Following this, the VAT (10%) and the power industry infrastructure fund (3.7%) are added, and the final charge of KRW 91,380 is imposed.

However, the burden of electricity bills was further relieved during the summer of 2018 by collecting consumer opinions that electricity bills were still burdened by the increased operation of air conditioners due to the record-breaking heat wave in the summer of 2018. The first stage of the progressive rate system was changed from 0–200 kWh to 0–300 kWh, the upper limit of the second stage was from 400 kWh to 500 kWh, and the lower limit of the third stage was 501 kWh from the previous 401 kWh. Temporarily discounted standards were applied for two months (July–August) in the summer of 2018. Since then, the summer discount policy of 2018 has been continuously applied every summer (July–August). Compared to the summer discount policy of 2018, it is a method to reduce consumer burden by adjusting only the upper limit of the second stage to 450 kWh ^[8]. [Table 1](#) summarizes three kinds of rates (other seasons, summer discounts applied since 2019, and 2018 summer discounts) for low voltage residential electricity.

Table 1. Residential electricity rates (low voltage) ^{[8][14]}.

| Stage | Basic Charge (KRW/Household) | Power Charge (KRW/kWh) | Other Seasons 1.1–6.30, 9.1–12.31 | 2019~ Summer 7.1–8.31 | 2018 Summer 7.1–8.31 |
|-------|---------------------------------|---------------------------|--------------------------------------|--------------------------|-------------------------|
| 1 | 910 | 93.3 | ~200 kWh | ~300 kWh | ~300 kWh |
| 2 | 1600 | 187.9 | 201–400 kWh | 301–450 kWh | 301–500 kWh |
| 3 | 7300 | 280.6 | 401 kWh~ | 451 kWh~ | 501 kWh~ |

The summer discount policy was initiated as a measure to ensure the cooling rights of those vulnerable to the heat waves, but it is difficult to obtain a practical effect in solving the securing of the cooling rights for these people by lowering electricity bills. The energy-poor people exposed to the heat waves have many households without air conditioners, so simply cutting their electricity bills does not secure cooling rights. In fact, the summer discount policy is a measure that allows households using electricity above average to consume more electricity at lower electricity bills.

For example, if 460 kWh is used in July, the basic charge is the same as KRW 7300, but the power charge is KRW 58,981 (300 kWh × KRW 93.3 + 150 kWh × KRW 187.9 + 10 kWh × KRW 280.6) with the summer discount policy, which is a reduction of KRW 14,095 from the previous price. Subsequently, by adding 10% VAT and 3.7% of the power industry infrastructure fund to the sum of the basic charge and the power charge, a total of KRW 75,350 will be charged, which is a KRW 16,030 discount from the KRW 91,380 before the summer discount is applied. In fact, households that use 460 kWh per month are households that use a lot of electricity, and it is questionable whether the KRW 16,030 reduction for one month in those households will help the household economy.

As of 2018, the average monthly household income of two or more households in Seoul was estimated at KRW 4.88 million ^[16] and the average monthly consumption expenditure per household was KRW 2,537,641 ^[17]. Of the total consumption expenditure, public transportation costs KRW 348,000 and telecommunication costs KRW 134,000 ^[17] but assuming that electricity usage is 300 kWh, which is the average value of the second stage, the electricity costs KRW 44,390 during the nonsummer season and KRW 32,850 during the summer. Therefore, since the electricity rates in Seoul currently account for about 1.7% of total consumption expenditure, these summer discounts are not likely to be of a great help to households, but rather can only increase the social burden. However, the average monthly household income of single-person households in Seoul was estimated at KRW 2.37 million in 2018 ^[16], which is much lower than that of two or more households. In particular, the average monthly income tended to decrease as individuals aged. The lowest-income individuals among the single-person households were in their 60s or above ^[18]. Therefore, since it is estimated that the share of electricity costs among the average monthly income for single elderly households is considered to be high, it is necessary to resolve this issue by lowering the requirements of the National Basic Living Security for single-person elderly households.

It was shown that the effect of discounted electricity rates on households was not significant. In particular, the proportion of electricity bills to household income does not seem to be significant even now. However, when the number of households and age are combined, that is, in the case of single-person elderly households, the burden of electricity bills is expected to be large, so we will examine the link between household electricity consumption and three factors (income, number, and age of household members).

Table 2 summarizes the electricity transaction results by energy sources in 2019 ^[12]. Korea is highly dependent on nuclear energy and coal to stably support the increasing demand for electricity due to urbanization and industrial development. The new government (2017.5~) has announced plans to gradually reduce nuclear power and coal power, expand eco-friendly power centered on renewable energy, and increase the amount of LNG power generation by reducing the cost gap between coal and LNG power generation by reflecting social and environmental costs ^[19].

Table 2. Electricity transaction results by energy sources in 2019 ^[12].

| | Nuclear Energy | Coal | LNG | Renewable Energy | Others | |
|--------------------------|----------------|---------|---------|------------------|--------|-----------|
| Transaction volume (GWh) | 138,607 | 217,342 | 141,933 | 33,446 | 9192 | 540,520 |
| | (25.6%) | (40.2%) | (26.3%) | (6.2%) | (1.7%) | (100%) |
| Unit cost (KRW/kWh) | 58.39 | 87.64 | 119.90 | 97.00 | 177.11 | 108.008 |
| | | | | | | (average) |

As such, considering the domestic situation in which nuclear energy (25.6%) and coal (40.2%) account for 65.8% of the total electricity transaction volume in Korea in 2019, lowering electricity rates means that it is difficult to reflect the energy conversion policy of government for the time being. In this situation, it is difficult to immediately push for the direction of de-nuclear and de-coal, so radioactive materials, nuclear waste, greenhouse gases, and fine dust are generated in the process of generating electricity from nuclear and coal power plants. Therefore, if electricity bills are cut as a countermeasure against heat waves caused by climate change, the burden of increasing electricity consumption will have an adverse effect on accelerating not only Korean society but also climate change. In addition, as shown in **Table 2**, the average unit cost of electricity transaction was KRW 108.01/kWh, whereas the average unit price for residential electricity rates was KRW 104.95/kWh as of 31 December 2019 ^[12], which means that consumer rates are not properly reflecting the change in cost of wholesale market. Therefore, it is necessary to revise the residential electricity tariff system to reflect the change in the cost of the wholesale market, rather than utilize the summer discount for the power charge.

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