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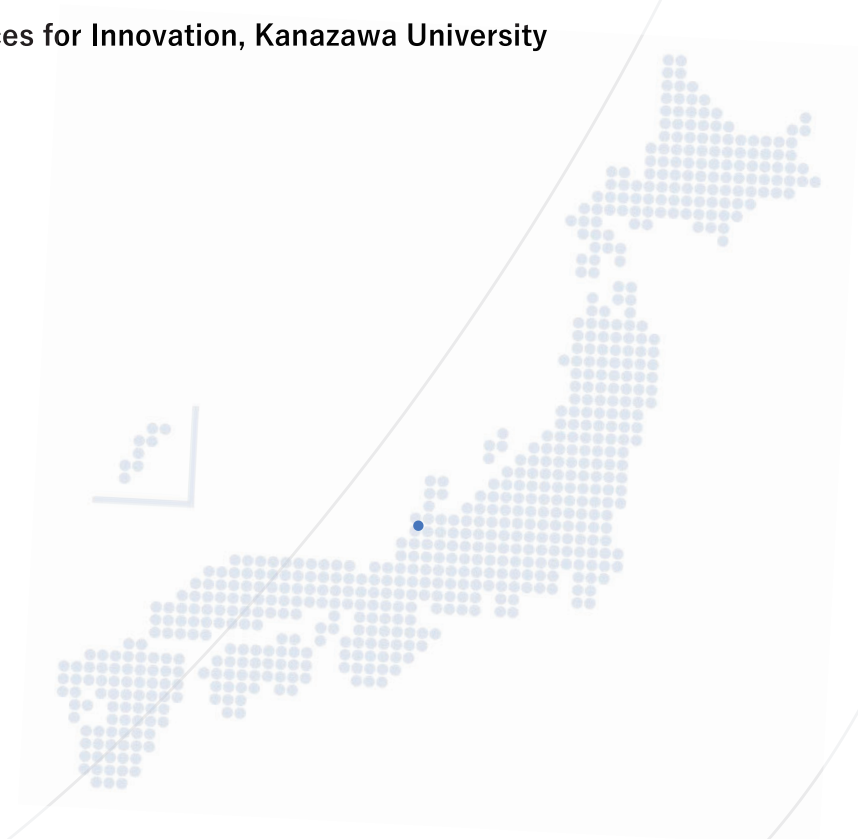
Kazuma Murakami
School of Environmental Science, The University of Shiga Prefecture

Ikuho Kochi
College of Transdisciplinary Sciences for Innovation, Kanazawa University



金沢大学
KANAZAWA UNIVERSITY

Providing electricity price information to households and reducing electricity consumption: Results from a field experiment in Japan

Kazuma Murakami[1*], Ikuho Kochi[2]

1. *University of Shiga Prefecture* 2. *Kanazawa University*

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*Corresponding author. e-mail: murakami.k@ses.usp.ac.jp

Abstract

Electricity accounts for 65.3% of household CO_2 emissions in Japan; therefore, more household energy conservation is needed. This study examines the effects of information provision on various household energy-saving behaviors using randomized controlled trials (RCT). For Japanese consumers who have recently become free to choose their electricity provider, we examine two types of information provision with the same economic incentives but different framing: *information on the Past* - information about historical changes in electricity bills for the average household of their electricity provider–and *information on Others* - information about differences in electricity bills for the average household of different electricity providers. We collected objective measures of household electricity consumption levels through meter readings and subjective measures of behavioral changes through a questionnaire. Our results show that *information on the Past* has more impact on reducing electricity consumption for households with a higher volume of electricity consumption than others. The channels for this reduction are the behaviors of "not leaving the air conditioner on," a constant time-consuming behavior, and "lowering the refrigerator's internal temperature," a hassle-free one-time behavior. *Information on the Past* can be a low-cost and proactive information-provision measure for local governments.

Keywords: information provision, social comparison, electricity consumption, energy-saving behaviour, randomized controlled trial

1. Introduction

Based on the Paris Agreement, Japan has set a goal of reducing greenhouse gas emissions by 46% in FY2030 compared to FY2013, with a 66% reduction in the household sector (Headquarters for promotion of global warming countermeasures in Japan, 2021). In Japan, electricity consumption accounts for 65.3% of CO_2 emissions from households (Ministry of the Environment, 2022); thus, households are expected to save even more electricity.

Japan's electricity retail market was fully liberalized in April 2016. This means all households can purchase electricity from the major electric power companies designated based on their residential location and other electric power companies. Since electricity prices differ by power companies,[1] households can purchase cheaper electricity from power companies outside their residential areas.[2]

Many studies have estimated the price elasticity of electricity consumption to understand the relationship between household electricity consumption and electricity prices (Espey and Espey, 2004; Labandeira et al., 2017; Pellini, 2021). Other studies are based on social experiments that change the unit price of electricity through dynamic pricing and examine its effect on electricity consumption (Borenstein, 2005; Ito et al., 2018; Jessoe and Rapson, 2014; Wolak, 2011). Although these studies clarify the extent to which changes in electricity prices promote electricity-saving behavior and reduce electricity consumption, their scope is limited to the effects of past or present electricity prices of the power companies with which a person contracts. Therefore, they do not provide information on the effect of other potentially important factor, other households' behaviors.

Reference Point Dependence in Behavioral Economics (Kahneman and Tverskey, 1979; Tverskey and Kahneman, 1991) indicates that one's future actions may be influenced not only by their past and present situation but also by the present situation of others. The studies mentioned above were conducted using the past or current electricity prices of an electricity company with which one had a contract as the reference point. However, compared with others, many studies have been conducted to verify the effects of *Social Comparison* (Festinger, 1954) by using the Home Energy Report (HER) to provide information about the electricity consumption level of neighboring households with similar attributes (Allcott, 2011a; Allcott and Rogers, 2014; Andor et al., 2020; Brandon et al., 2019). They examined whether information about the difference in electricity consumption levels between oneself and others may induce more energy-saving behaviors. Household electricity charges are basically determined by the "unit price of electricity × electricity consumption levels". Therefore, it is assumed that people would become aware of the difference in electricity charges between themselves and others once they recognize the differences in "electricity consumption levels". Therefore, it has been verified that energy-saving behavior is induced by using the same level of electricity charges as others as a benchmark. However, it has not been verified whether energy-saving behavior is induced by making people aware of the

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[1] In Japan, the Feed-in Tariff (FIT) was introduced in 2012, and the FIT burden is uniformly added to household electricity bills. The amount of this burden is increasing year by year as the amount of renewable energy introduced increases. In addition, due to Japan's fuel cost adjustment system, the unit price of electricity changes in tandem with the price of fossil fuels. As a result, electricity prices for Japanese households differ from those of other households due to differences in the power supply mix of the electricity companies with which they contract.

[2] Before April 2016, 10 major electric companies with defined supply zones provided electricity to households. The number of registered retail electricity providers was 407 in July 2017 at the time of the survey and 752 as of March 2022 (Agency for Natural Resources and Energy, 2022).

difference in "unit price" between themselves and others.

In other words, we do not know how much the electricity consumption changes when one assumes a change in the electricity company and sets a reference point for the electricity prices of other electricity companies. For example, no studies have examined which group (a) or (b) has a higher energy reduction. As the reference point, the Past and Others groups have the same $5 monetary incentive, but it has not been examined whether one acts more strongly on loss aviation and makes a difference in electricity-saving behavior.

(a) Current energy consumption (e.g., 300 kWh/month) is the same as a year ago, but the electricity bill is $5 higher than the previous year (Past group)

(b) Current energy consumption (e.g., 300 kWh/month) is the same as others having contracts with other power companies; however, the electricity bill is $5 higher than that of others (Others group).

As shown in (b), the effect of information that makes people aware of differences in electricity prices based on differences in the unit price of electricity has not been verified, even though they consume the same amount of electricity as others. In other words, no studies have used the electricity unit price of others as a social comparison, but rather the electricity consumption of others.

Another difference between this study and other studies using the HER on social implementation is the difference in the cost of providing information. The HERs are expensive because they present customized information for each household. Furthermore, the HER is a power company-driven information provision measure based on each household's electricity consumption information, available only to electric power companies. However, information on the unit price of electricity for each electric power company is generally posted by electric power companies on their websites to provide evidence of how fossil fuel prices are reflected and to attract customers. Therefore, anyone can obtain this information without any cost. This could lead to low-cost and feasible information provision measures by local governments rather than relying on electric power companies. It is also an easy measure for local governments to implement from the standpoint of protecting personal information, as they do not need to obtain information on the electricity consumption of each household.

In Japan, several municipalities in the Tokyo metropolitan area have implemented information campaigns to encourage households to save electricity. They presented data on the upward trend in electricity prices for a household with standard electricity consumption (260 kWh/month) that contracts with the Tokyo Electric Power Company. However, their electricity-saving effects have not been verified. It also has not provided comparative information on the low electricity charges of other electric power companies. It is necessary to clarify the kind of comparison (reference point) that should be used to make people aware of their high electricity bills to encourage more energy-saving behavior. This leads to proposals for more effective information provision measures. This will have implications for information provision measures by local governments not only in Japan, but also in other countries and regions where awareness of electricity unit prices is low or is not keeping pace with the rising trend due to soaring fossil fuel prices and carbon pricing.

This study aims to identify electricity price information based on electricity unit prices that would promote energy-saving behavior among Japanese consumers, who have recently become free to choose their electricity provider. We use randomized controlled trials (RCT) to examine whether there are differences in electricity use between the three groups, considering the different information. The three groups are *Past group*, providing information comparing current electricity prices to past electricity prices (which are lower than current prices); *group on Others*, providing information comparing current electricity prices to that of other electric companies (which are lower than their own electricity companies); and *the control group.*

In addition, the mechanism of electricity consumption reduction (Allcott and Rogers, 2014; Ito et al., 2018) is clarified. We examined the impact of the information on specific electricity-saving behaviors in the top four appliances (air conditioners, refrigerators, televisions, and lighting) with the highest electricity consumption (kWh) in Japanese households (Ministry of the Environment, 2017). This allowed us to examine the channels through which the intervention affected the changes in electricity consumption. In doing so, we examine not only time-consuming behaviors that need to be considered on a daily basis (e.g., not leaving the TV on), but also hassle-free behaviors (e.g., setting the TV to an energy-saving mode) that have long-term effects. This study also examines the possibility of the long-term power-saving effects of electricity price information that can be collected without cost.

The main results are as follows: First, information in the Past group (information on the Past) leads to reducing electricity consumption (kWh/day) in households with high electricity consumption. Second, as a mechanism for reducing electricity consumption, past information and information in the group on Others (information on Others) influence the behavior of not leaving the air conditioner on, which is a time-consuming, energy-saving behavior. Third, in hassle-free behavior, information on Others influences the behavior of lowering the refrigerator's internal temperature. Furthermore, past information influences the behavior of lowering the refrigerator's internal temperature in households with high electricity consumption. In summary, information on the Past reduced electricity consumption in households with high electricity consumption and the behaviors of not leaving the air conditioner on and lowering the temperature inside the refrigerator contribute to this reduction. Nonetheless, information on Others influences the behavior of lowering the temperature inside the refrigerator and not leaving the air conditioner on, but it does not contribute to reducing electricity consumption.

The contributions of this study are as follows: First, studies and social implementation of social comparison, electricity pricing, and energy-saving behavior. In this study, we set the unit price of electricity for other people, rather than their electricity consumption, as the object of social comparison. In addition, we exogenously provided two reference points, own past electricity prices and others' current electricity prices, to examine the differences in their effects on electricity-saving behavior. To the best of our knowledge, such studies have not been conducted earlier. Regarding social implementation, the information provided in this study can be implemented by local governments and is expected to contribute to CO_2 reduction in the municipality. Second, the study analyzes the mechanism of electricity consumption reduction due to the intervention. Most intervention studies using RCT have focused on evaluating macro electricity savings (kWh), and few studies have examined the impact on specific electricity-saving behavior (McAndrew et al., 2021). Ito et al. (2018) examined the intervention effects of home appliances on electricity-saving behaviors in Japanese households. However, the study was limited to analyzing data asking whether they used each of the five targeted appliances efficiently.

Additionally, some of the five appliances did not consume electricity significantly. In this study, we set nine specific power-saving behaviors for the top four appliances (air conditioners, refrigerators, televisions, and lighting) that consumed the most electricity (kWh) in Japanese households and examined the impact of interventions on them.

This paper is organized as follows. Section 2 presents a literature review, Section 3 presents the methodology and data, Section 4 presents the results and discussion, and Section 5 presents the conclusions and policy implications.

2. Literature review

2.1 Study of electricity prices and electricity consumption

Several studies have examined the price elasticity of electricity consumption. Many early studies used macro data to estimate short- and long-term price elasticities and made international and domestic regional comparisons (Espey and Espey, 2004). Subsequently, with the development of individual data, many studies have used micro-and micro panel data to conduct analyses controlling for household attributes (Baker and Blundell, 1991; Branch, 1993; Halvorsen and Larsen, 2001; Meier et al., 2013; Nesbakken, 1999; Schulte and Heindl, 2017). These studies contribute to the recent increase in fossil fuel prices and the carbon pricing debate. However, it is not always possible to measure consumer responses to explicitly perceived changes in electricity prices because these studies are not experimental.

Many experimental studies on the relationship between electricity prices and electricity consumption have been conducted by changing the unit price of electricity through dynamic pricing, making consumers aware of changes in electricity prices, and analyzing their impact on electricity consumption (Allcott, 2011b; Borenstein, 2005; Fowlie et al., 2021; Herter, 2007; Ito et al., 2018; Jessoe and Rapson, 2014; Wolak, 2011).[3] However, as a matter of course, these studies are designed to examine the response to changes in the unit price of electricity of the electricity company with which one contracts. Therefore, verifying the response to changes in the unit price of electricity when the contract is changed to another electricity company at cost is beyond the scope of these studies.

Nevertheless, intervention studies have been conducted to verify the impact on electricity consumption by providing comparative information on the electricity consumption of others and oneself through the HER and making them aware of the differences (Allcott, 2011a; Allcott and Rogers 2014; Andor et al., 2020; Ayres et al., 2012; Brandon et al., 2019; Byrne et al., 2018; Crago et al., 2020; Costa and Kahn, 2013; Myers and Souza, 2020; Ruokamo et al., 2022). These studies provide information on the electricity consumption of neighboring homes with similar attributes. However, these studies examined only the effect of social comparison on differences based on electricity consumption. Therefore, no intervention studies have examined the impact of electricity consumption by making people aware of the difference in the unit price of electricity from others where electricity consumption is equal to others. In other words, no studies have used the unit price of other people's electricity for social comparison rather than their electricity consumption as the object.

[3] Numerous experiments have also been conducted with rebate-type incentives based on electricity reductions, rather than billing-type incentives that vary the unit price of electricity. Studies targeting Japanese consumers include Mizobuchi and Takeuchi (2013) and Murakami et al. (2022).

Moreover, since the HER also contains information on one's past electricity consumption, it is not possible to determine whether this information or that on others' electricity consumption influenced power-saving behavior. Furthermore, regardless of the method of HER provision (e.g., mail, e-mail, Web), the cost of collecting and processing information is high because the information is tailor-made for each household. Moreover, it is an information provision measure by the electric power company and cannot be proactively implemented by the local government. The same applies to measures based on dynamic pricing. This study proposes a low-cost information-provision measure using unit electricity prices that local governments can implement to encourage households to save energy.

2.2 Study of mechanisms for reducing electricity consumption

Studies have identified mechanisms for reducing electricity consumption, and the effects of energy conservation behavior and capital investment have been compared. (Allcott and Rogers, 2014; Brandon, et al., 2017; Ito et al., 2018). Brandon et al. (2017), in a meta-analysis of 38 field experiments with HERs in the U.S., showed long-term electricity consumption reductions as an effect of capital investment but not energy conservation behavior. However, Allcott and Rogers (2014) examined the effect of HER on electricity consumption reduction in a long-term experiment of 4-5 years in the United States. They found that energy conservation behavior had a large effect, whereas capital investment had a small effect. Ito et al. (2018) examined the effect of dynamic pricing on electricity consumption reduction for Japanese households in summer and winter over two seasons. They showed that this effect was due to energy conservation behavior.

Different results have been reported depending on the intervention method, duration, and target region. We excluded capital investment in this study to clarify the short-term intervention effects of providing one-time information. We then examined the content of energy conservation behavior in more detail, based on Ito et al. (2018), who targeted Japanese households. Ito et al. (2018) targeted the efficient use of each of the five appliances for energy conservation. The five appliances were air conditioners, electric heaters, personal computers, washers, and vacuum cleaners. However, the study was limited to analyzing data asking whether they used each appliances efficiently. They did not measure the implementation of specific power-saving behaviors; therefore, each respondent's judgment of the efficient use of appliances may differ. In addition, some of these five appliances did not consume electricity significantly. Therefore, it is insufficient to verify the mechanism of the reduction in macro-electricity consumption (kWh).

This study sets nine specific power-saving behaviors in the top four appliances (air conditioners, refrigerators, televisions, and lighting) that consume the most electricity (kWh) in Japanese households and examines the impact of interventions on them. In doing so, we examine not only the six time-consuming power-saving behaviors that need to be implemented daily but also the three hassle-free power-saving behaviors that, once implemented, will continue to be effective over the long term. This allowed us to consider the possibility of long-term power-saving effects of a single simple intervention.

3. Methodology and data

3.1 Research design

We set up two reference points–information on the Past and information on Others–and examined which information would encourage more energy-saving behavior among Japanese consumers using an RCT. Two online questionnaire surveys were conducted in July and September 2017. Information was provided in July, and changes in electricity consumption and implementation of energy-saving behaviors were measured in September.

This survey was conducted among Japanese consumers who could freely choose their electricity provider since April 2016 and had not changed them as of July 2017, during the survey period. In July 2017, approximately one year after the liberalization of the retail electricity market, the share of electricity sold by new entrants to the market was 6.1% (Agency for Natural Resources and Energy, 2017). Thus, it is assumed that the awareness of deregulation of the retail electricity market and the electricity unit prices of other companies was low in this period. Therefore, we believe that presenting electricity charges based on other companies' electricity unit prices in this survey makes people aware of the differences in electricity prices from other companies. It is assumed that some consumers would be aware of other companies' electricity unit prices even if they have not changed their electricity providers. Since changing electricity providers requires switching costs, some consumers may have abandoned the idea of changing electricity providers by comparing the expected reduction in electricity prices. Murakami and Ida (2019) analyzed the willingness of Japanese households to switch electricity providers and found that they would not even if there was a 5% cost reduction. They attribute this to the influence of status-quo bias. Therefore, even if consumers are aware of other companies' electricity unit prices if they are presented with the option of saving electricity instead of changing electricity providers, they are likely to adopt cheaper energy-saving behaviors than changing electricity providers. Based on the above, the information provided to this survey target using the electricity prices of other companies may impact electricity consumption.

In the first survey in July 2017, we obtained demographics and other information about the respondents. Finally, an intervention was conducted to randomly present one of the three types of electricity price information.

The second survey, a follow-up to the first one, conducted in September 2017. First, the electricity consumption (kWh) and duration in August 2016 and August 2017 were ascertained based on meter readings.[4] This allowed us to calculate the average daily electricity consumption (kWh/day) in August 2016 as a baseline before the intervention, and the average daily electricity consumption (kWh/day) in August 2017 after the intervention. From these data, we calculated the percentage change (%) in average daily electricity consumption (kWh/day) due to the intervention. Additionally, the implementation status of nine specific power-saving behaviors for four home appliances (air conditioners, refrigerators, televisions, and lighting) and their willingness to switch power companies was ascertained in August 2017. This allowed us to analyze the impact of information on the Past and Others on the rate of change in electricity consumption, the implementation of specific electricity-saving behaviors, and the

[4] The monthly meter reading slip of the subscribers to Kansai Electric Power Company (KEPCO), which is the subject of the study, contains information on electricity consumption and usage periods not only for the year in question but also for the same period in the previous year. Since the monthly meter reading date for each household is almost the same (e.g., the 30th of each month), the rate of the average daily electricity consumption (kWh/day) changes can be calculated for each month.

willingness to change electricity providers.

The electricity charge information to be provided at the RCT is based on the electricity bill payment (yen/month) for a household with standard Japanese electricity consumption (260 kWh/month). Japanese households can confirm their electricity consumption (kWh/month) and electricity bill payments (yen/month) using monthly meter readings. Hence, the perceived electricity prices by the household are not the unit price of electricity (yen/kWh) but the amount paid for electricity (yen/month). Therefore, the electricity bill payment (yen/month), more highly recognized by people and calculated based on the electricity unit price, is used as the target of social comparison. In addition, each major electric power company publishes the monthly electricity charges (yen/month) for a household with standard electricity consumption (260 kWh/month) on its website. This amount is calculated based on the electricity unit price (yen/kWh) of each electric power company × 260 kWh/month, and the transition from the past can also be viewed. This study aims to contribute to the information provision measures of local governments based on information that can be collected without cost. Based on the above, the electricity charge information to be presented is the electricity bill (yen/month) paid by a household with standard electricity consumption (260 kWh/month) and can be easily collected and understood by consumers.

The specific information provided for the three groups (intervention groups 1 (Past group) and 2 (group on Others) and the control group) is shown below and in Fig. 1. As an equivalence frame, the time periods within the Past group were set such that the amounts for the Past and Others' groups were equal to 500 yen (about $4.5). [5]

- Intervention group 1 (Past group): Information is presented that the current electricity bill payment is about 500 yen higher than in the past, although electricity consumption remains the same. This figure was calculated using the amount in July 2017 at the time of the survey and the amount in December 2016, seven months earlier, for a household with standard electricity consumption (260 kWh/month) having a contract with Kansai Electric Power Co. (KEPCO). (Top of Fig.1).
- Intervention group 2 (group on Others): Information is presented that their current electricity bill payment is approximately 500 yen higher than that of the others, although their electricity consumption is equal. This figure was calculated from the amount in July 2017 for a household with standard electricity consumption (260 kWh/month) contracted with KEPCO and the amount in July 2017 for that with standard electricity consumption (260 kWh/month) contracted with Chubu Electric Power Co., [6] a major power company in the neighborhood. (Middle of Fig.1).
- Control group: Information is presented on the electricity bill payments of a household with standard electricity consumption (260 kWh/month) having a contract with KEPCO for three months ending July 2017. (Bottom of Fig.1).

< Fig.1. >

[5] Calculated at the July 2017 exchange rate: $1 = 110.63 yen.

[6] At the time of the survey, Chubu Electric Power Co. was the third largest electric power company after Tokyo Electric Power Company and KEPCO in Japan. This company was also a major power company before the full deregulation of the electricity retail market in April 2016, so it is highly recognized by consumers and assumed to be highly reliable as an electricity company to switch to. In addition, before the full liberalization of the electricity retail market, this company's electricity supply area was adjacent to that of KEPCO. Therefore, we used data from Chubu Electric Power Co. rather than that from new entrant electric power companies with cheaper electricity prices.

3.2 Setting up the survey subjects

The survey participants were housewives who lived in Osaka Prefecture, who had a contract with KEPCO, and were home during the daytime on weekdays. The selection process was as follows:

To present information on the electricity bill payment of a household with standard electricity consumption (260 kWh/month) having a contract with KEPCO, we first defined the scope of the survey to include subscribers to KEPCO. KEPCO has been a major electric power company before the full liberalization of the retail electricity market. Therefore, residents who did not change their electric power companies at the time of the survey were included. Next, we narrowed the sample to residents of Osaka Prefecture among them. The rate of change in the average daily electricity consumption (kWh/day) was calculated from the electricity consumption (kWh) in August 2016 and August 2017 listed in the meter readings. The rate of change was estimated after adjusting for temperature by including cooling-degree days in the model.[7] Osaka Prefecture is the second smallest of Japan's 47 prefectures, with an area of 1,905 km^2, and the weather conditions do not vary significantly within the prefecture. Therefore, the analysis was limited to residents of Osaka Prefecture to measure the rate of change in electricity consumption more accurately. In addition, we included regional fixed effects by dividing Osaka Prefecture into eight districts.

The survey targeted housewives at home during the daytime on weekdays among the residents of Osaka Prefecture mentioned above, having contracts with KEPCO. Since the accident at the Fukushima Daiichi Nuclear Power Plant following the Great East Japan Earthquake in 2011, many nuclear power plants in Japan have not restarted even after periodic inspections, and the power supply is insecure on weekdays during summer heat waves. Additionally, CO_2 emissions must be reduced to prevent global warming. That is, reductions in the maximum power consumption (kW) and power consumption (kWh) are required. Therefore, it is important to save electricity for residents who consume large amounts of electricity because they are home during the daytime in summer and have a large potential to reduce their electricity consumption. Housewives who stay at home on weekdays in the summer meet this condition.

Based on the above, we first selected those participants who resided in Osaka Prefecture, subscribed to KEPCO, and were housewives from among the monitors of an online survey company. Screening questions were then used to select respondents who indicated that they were generally at home during the daytime on weekdays during the summer of 2016 (July–September) and 2017 (July–September). Finally, a screening question was used to select respondents who indicated no major changes in the external environment related to electricity consumption during this period (no relocation, no dwelling extension or renovation, no change in the number of people living together, or no solar power installation) as the final target group. The participants were then asked to respond to the questionnaire. Data were collected from 394 respondents.

3.3 Analytical frames and models

[7] Since the monthly meter reading dates differ among households, the cooling degree days vary for each household. Therefore, the cooling degree days were calculated for each household by adding up the number of eligible days within the electricity usage period.

The analysis model is shown in Equation (1). Ordinary least squares (OLS) was used to examine the differences in the impact of different electricity-pricing information on electricity consumption.

$$\Delta Y_i = \alpha + \beta_1 \text{Past}_i + \beta_2 \text{Others}_i + \beta_3 X_i + \theta_i + \varepsilon_i \quad (1)$$

ΔY_i is the percentage change in average electricity consumption due to the intervention. ΔY_i is calculated as $((\text{Electricity2017}_i - \text{Electricity2016}_i) / \text{Electricity2016}_i) \times 100$.[8] Electricity2016_i is the average daily electricity consumption (kWh/day) in August 2016 before the intervention as a baseline for i. Electricity2017_i is the average daily electricity consumption in August 2017 after the interventions for i. From this, a negative ΔY_i means that electricity consumption was reduced in August 2017 compared to August 2016. Past_i is a dummy variable that takes the value of 1 if household i is in the Past group. Similarly, Others_i is a dummy variable that takes the value of 1 if household i is in group on Others. β_1 and β_2 measure the average treatment effect (ATE) for each information provision on outcome ΔY. Thus, β_1 and β_2 express the average electricity savings as a percentage of the average consumption level. X_i is the vector of the control variables for the socioeconomic characteristics of households and other information for i from the questionnaire survey. θ_i is a ward dummy, and Osaka Prefecture is divided into eight wards. ε_i is an individual-specific error term.

X includes Electricity2016, ΔCDD, awareness of retail electricity market deregulation, annual household income,[9] age, number of household members, and housing type (dummy variable for detached houses = 0; apartment buildings = 1). CDD is the number of cooling degree days and is the sum of the difference between the average daily temperature on days when the average daily temperature exceeds 24 degrees Celsius and the base temperature of 24 degrees Celsius over the period under study. ΔCDD is the cooling degree days in August 2017 (CDD2017_i) minus the cooling degree days in August 2016 (CDD2016_i) for i. From this, if ΔCDD is positive, then for i, August 2017 was a weather condition with greater cooling demand than August 2016. Awareness of retail electricity market deregulation was measured on a 6-point Likert-type scale in the first survey conducted in July 2017.[10] This item was set up because intervention group 2 (group on Others) presented information on the electricity prices of Chubu Electric Power Co., another electricity company different from KEPCO.

Next, as an additional analysis, we set up Model (2), in which the objective variable is the willingness to change electricity providers after the intervention and examine it using OLS.

$$\text{Company change}_i = \alpha + \beta_1 \text{Past}_i + \beta_2 \text{Others}_i + \beta_3 X_i + \theta_i + \varepsilon_i \quad (2)$$

Company change_i is the willingness of i to change its electricity provider. This was measured in the second survey conducted in September 2017 on a 6-point Likert-type scale regarding the willingness to change electricity companies.[11] This verification was conducted to present group on Others with electricity rate information based on Chubu Electric Power's electricity unit prices, which are lower than those of KEPCO. This verification examines whether information on Others impacts switching

[8] Based on Andor et al. (2020) and Mizobuchi and Takeuchi (2013), ΔYi was set as the objective variable. For ease of interpretation, ΔYi is multiplied by 100 and expressed as a percentage, as in Andor et al. (2020) and Mizobuchi and Takeuchi (2013).

[9] There were 54 respondents who "don't know/don't want to answer."

[10] For the question, "I know in detail about the liberalization of the electricity retail market since last April 2016 (e.g., It is now possible to purchase electricity from power companies other than KEPCO)," we measured on a 6-point Likert-type scale from 6 = strongly agree to 1 = not at all agree.

[11] The question "I would like to change my electricity purchaser" was measured on a scale of 6 = strongly agree to 1 = not at all agree.

electricity providers, which would be relatively costlier than hassle-free energy-saving behavior owing to switching costs. [12] If this hypothesis is confirmed and local governments' information policies address residents' lack of information about retail electricity market deregulation and consumers switch to electricity companies with lower electricity prices, this will increase residents' benefits.

Finally, to verify the mechanism of electricity consumption reduction, Model (3) was set up, in which the objective variable was the implementation of nine specific electricity-saving behaviors for four home appliances (air conditioners, refrigerators, televisions, and lighting) after the intervention.

$$Behavior_{i,j} = \alpha + \beta_1 \, Past_i + \beta_2 \, Others_i + \beta_3 \, X_i + \theta_i + \varepsilon_i \qquad (3)$$

$Behavior_{i,j}$ is the implementation status of the power-saving behavior j by i. j consists of nine power-saving behaviors. [13] First, there are six time-consuming energy-saving behaviors that need to be implemented daily. Next, there are three hassle-free energy-saving behaviors that, once implemented, remain effective for a long period. These were measured in a second survey conducted in September 2017. Six time-consuming energy-saving behaviors were measured on a 5-point Likert-type scale. [14] Three hassle-free energy-saving behaviors were measured on a 2-point scale: implemented or not implemented. [15] These nine power-saving behaviors were analyzed by OLS based on Angrist and Pischke (2009). [16]

3.4 Data

Descriptive statistics are shown in Table 1. A balance test was also performed by testing for differences in the means. The results were statistically non-significant except for Kitakawachi in Ward, and the randomization was generally successful. As mentioned above, Ward was included in the model as a control variable.

< Table 1 >

As shown in Table 1, the average daily electricity consumption in August 2016 was 12.271 kWh/day. The average electricity consumption in August 2017 was calculated 12.536 kWh/day, increasing from August 2016. One possible reason for this result is that ΔCCD is positive from Table 1, indicating a

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[12] Studies examining savings as a factor in changing electricity providers include Buryk et al. (2015), Daglish (2016), Ek and Söderholm (2008) and Giulietti et al. (2005). Murakami and Ida (2019) and Shin and Managi (2017) are among the studies covering the liberalization of the retail electricity market in Japan.

[13] As in Ito et al. (2018), we set the implementation of power-saving behavior of appliances after the intervention as the objective variable.

[14] The following six questions were asked, each of which was measured using a five-point scale: "Almost did it (100%) - Generally did it (75%) - Occasionally did it (50%) - Not very much did it (25%) - Almost never did it (0%)".The level of implementation of each option (100%, 75%, 50%, 25%, 0%) was then taken as an interval scale and scored from 5 to 1. Six questions: "Air conditioner 1: I set the temperature to 28°C" (AC_28°C), "Air conditioner 2: I do not leave the air conditioner on unnecessarily" (AC_leave), "Refrigerator 1: I do not overfill my fridge with stuff" (Fridge_stuff), "Refrigerator 2: I open and close the door less frequently and shorter" (Fridge_leave), "TV: I turn it off unless I need it" (TV_leave), "Lights: I frequently turn off lights that are not needed" (Light_leave).

[15] The following three questions were set, and each was measured on a scale of 1 = implemented and 0 = not implemented. The three and six power-saving behaviors mentioned above were adopted from the power-saving items recommended by The Energy Conservation Center, Japan (2012). The hassle-free power-saving behavior related to lighting was not set in this study because it was not indicated in this document. Three questions: "Air conditioner: avoid placing objects around the outdoor unit to improve ventilation" (AC_outdoor unit), "Refrigerator: set the temperature inside the refrigerator to "medium" or "low" (Fridge_cooling intensity), and "TV: set the TV to energy-saving mode so that the screen is not brighter than necessary (TV_energy-saving mode).

[16] Ito et al. (2018) also analyzed the implementation of the energy-saving behaviors measured by binary choice in OLS. As discussed later, these three energy-saving behaviors measured with binary choice were also analyzed by probit model to verify their robustness.

greater cooling demand in August 2017 than in August 2016.

Next, KEPCO set the electricity consumption of a standard household at 260 kWh/month; however, the average electricity consumption of the target of this study, a housewife's household who was home during the daytime on weekdays, in August 2016 was 380 kWh/month (12.271 kWh/day × 31 days). This is approximately 1.5 times the electricity consumption of a standard household, confirming its suitability as a policy target.

4. Results and discussion

4.1 Electricity consumption

The analysis results of model (1) with ΔY as the objective variable are presented. The average treatment effect is shown in column (2) of Table 2, where the coefficients for Past and Others are negative, but neither is significant.

< Table 2 >

The coefficient of Electricity2016 was negative and significant, with every 1 kWh/day associated with a 0.541% reduction in electricity consumption. This implies that households that consumed more electricity in August 2016 consumed less. This result is similar to those of Allcott (2011b), Andor (2020), Knitelle and Stlper (2019) and Matsukawa (2018). Households with high electricity consumption can be considered as having great potential for electricity consumption reduction. Therefore, even a small amount of electricity-saving behavior with a low marginal cost is likely to reduce electricity consumption. The analysis results were considered to have been strongly influenced by the power-saving effects of households with high electricity consumption.

In contrast, the large cooling demand as the size of ΔCCD and the large number of household members were factors increasing electricity consumption.

The next step was to examine heterogeneity. From a cost-effectiveness perspective, it is desirable to identify the information that greatly impacts households with higher electricity consumption. Therefore, we examined the interaction term between electricity consumption in August 2016 and the information provided. As shown in column (3) of Table 2, the coefficient of Past×Electricity2016 is significant at -0.713, indicating that information on the Past promotes electricity savings for households that consumed more electricity in August 2016. Ito et al. (2018) showed that the intervention effect of economic incentives was greater for households with higher electricity consumption, which is consistent with the results of this analysis. The average electricity consumption of the participants in August 2016 was 380 kWh/month. This is possibly because households with higher electricity consumption were expected to bear a larger monetary burden than the 500 yen increase in their standard electricity consumption (260 kWh/month), as indicated by the past information.

4.2 Willingness to change electric power companies

The following are the results of the Model (2) analysis with *Company change* as the objective variable. As shown in Column (5) of Table 2, the coefficient of Others is negative and significant, which means that information on Others reduces the willingness to change electricity providers. In addition, the coefficient of Electricity2016 is negative and significant.

The interpretation of these results is assumed to have been influenced by the small savings of 500 yen/month, the difference between KEPCO and Chubu Electric Power Co., as indicated in the information on Others. It is considered that the decision to switch electric power companies was based on a comparison of the amount saved and the switching costs of changing electric power companies. Only small savings of 500 yen were considered to have functioned as decision-making information, especially for households with high electricity consumption; that is, households with large electricity payments. In other words, it is possible that households with high electricity consumption assumed that the electricity company change would lead to a larger decrease than the 500 yen in savings for households with standard electricity consumption (260 kWh/month) but believed that the assumed switching cost would offset this effect. Murakami and Ida (2019) analyzed the willingness of Japanese households to switch electricity providers and found that they would not even for a 5% cost reduction. Information on Others in this study showed a cost reduction of 7.3% (500yen/6,890yen), but the willingness to change electric power companies decreased.

Contrarily, numerous household members and high awareness of retail electricity market deregulation increase the willingness to change electricity providers. The effect of awareness of the retail electricity market deregulation in Japan is similar to that of Murakami and Ida (2019) and Shin and Managi (2017), suggesting a possible lack of information about retail electricity deregulation among consumers. This result suggests that local governments should inform residents regarding retail electricity deregulation.

Further, as a test of heterogeneity, we examined the interaction term between Electricity2016 and the information provided; however, as shown in column (6) of Table 2, no significant results were obtained.

4.3 Power-saving behavior

The following are the results of the Model (3) analysis, with *Behavior* as the objective variable. The results for time-consuming power-saving behavior are shown in Section 4.3.1, and the hassle-free power-saving behavior in Section 4.3.2.

4.3.1 Time-consuming power-saving behavior

Table 3 presents the average treatment effect results of the six time-consuming electricity-saving behaviors. As shown in Column (2), coefficients of both Past and Others are positive and significant for AC_leave (not leaving the air conditioner on). This means that Past and Others' information influenced the behavior of not leaving the air conditioner on. However, the coefficients of Past and Others were not significant in column (1) AC_28°C (set the air conditioner to 28°C).

< Table 3 >

Given the weather conditions in Japan, many housewives who are home during the daytime in summer are likely to use air conditioners. As an air conditioner's energy-saving behavior is based on the intervention of information on the Past or Others, the behavior of not leaving the air conditioner on was selected instead of setting the air conditioner at 28 degrees Celsius. This result can be considered to represent a relatively easy-to-implement air conditioner power-saving behavior. Ito et al. (2018) showed that the intervention promoted the efficient use of air conditioners. This study further clarified specific power-saving behaviors for efficient use of air conditioners.

Next, in column (2) of AC_leave, the coefficient of Electricity2016 is negative and significant. This means households that consumed more electricity in August 2016 did not implement the behavior of not leaving the air conditioner on. The same result holds for the other five behaviors listed in Table 3. Furthermore, the correlation coefficients between Electricity2017 and these six electricity-saving behaviors ranged from -0.116 to -0.238, all significant at the 5% level. This suggests that implementing these six behaviors contributes significantly to electricity consumption.

From the above, it can be stated that the information on the Past and Others influenced the behavior of not leaving the air conditioner on, contributing to electricity consumption. Even a one-time provision of information influences time-consuming behaviors that should be implemented daily.

In addition, in Table 4, we test the interaction of Electricity2016 and the information provided as a test of heterogeneity. The results were not significant for any of these behaviors.

< Table 4 >

4.3.2 Hassle-free power-saving behaviors

Table 5 shows the results of the average treatment effects of the three hassle-free one-time electricity-saving behaviors.[17] As shown in column (3), the coefficient of Others' is positive and significant for Fridge_cooling intensity (lowering the refrigerator's internal temperature). This implies that information on Others influences the behavior of lowering the refrigerator's internal temperature.

< Table 5 >

Additionally, the coefficient of Electricity2016 is negative and significant. This means households consuming more electricity in August 2016 did not implement measures to lower their refrigerators' internal temperatures. The same result was observed for the AC_outdoor unit in column (1) (avoid placing objects around the outdoor unit to improve ventilation). Furthermore, the correlation coefficients between Electricity2017 and these two power-saving behaviors were -0.096 and -0.092, respectively, and both were significant at the 10% level. This suggests that the implementation status of these two behaviors significantly contributes to electricity consumption. From these results, it can be stated that information on Others influenced the behavior of lowering the temperature inside the refrigerator, which contributed to electricity consumption.

Based on the above, we summarized the results for information on Others. As shown in column (5) of Table 2, information on Others negatively impacts willingness to change electric power companies. However, column (2) in Table 3 and column (3) in Table 5 show that information on Others affects the behavior of not leaving the air conditioner on and lowering the temperature inside the refrigerator. However, as shown in columns (1)–(3) of Table 2, information on Others does not significantly affect ΔY (electricity consumption).

Next, regarding the heterogeneity test results, as shown in Column (4) of Table 5, the coefficient of Past x Electricity2016 is positive and significant. This means that past information influenced the behavior of lowering the refrigerator's internal temperature in households with high electricity consumption in August 2016.

Based on the above, we summarize the results of the past information. Information on the Past reduces

[17] Table A1 shows the probit estimation results as a robustness test. Signs and significance are the same as in Table 5 except for Constant.

the electricity consumption (kWh/day) of households with high electricity consumption in August 2016, as shown in column (3) of Table 2. The channels for this are the behavior of not leaving the air conditioner on, as shown in column (2) of Table 3, and the behavior of lowering the temperature inside the refrigerator in households with high electricity consumption in August 2016, as shown in column (4) of Table 5.

5. Conclusions and policy implications

This study examines the information provision for reducing household electricity consumption using electricity charges based on others' electricity unit prices, rather than others' electricity consumption used in the HER, as the object of social comparison. To clarify the mechanism of electricity consumption reduction, we examined the effects of nine specific electricity-saving behaviors on the four appliances with the highest electricity consumption in Japanese households. Through these analyses, we clarify how presenting electricity charge information, when easily collected, can encourage residents to save electricity. The social significance of this study is that it provides suggestions for information provision measures that can be proactively implemented by local governments. In addition, this study aims to contribute academically to two research areas: social comparison, electricity prices, electricity-saving behavior, and mechanisms for reducing electricity consumption.

The analysis results showed that information on the past electricity charges of the electricity company to which one subscribes reduces electricity consumption in households with high electricity consumption. However, information on Others–information on electricity charges of other electricity companies - influenced some electricity-saving behavior but did not contribute to reducing electricity consumption. As a simple information provision measure, using past information is more effective. Past information is that municipalities can collect at low cost without violating residents' privacy. Therefore, this shows the possibility of low-cost information provision by local governments instead of the relatively costly tailor-made HER and dynamic pricing for each household, mainly conducted by electric power companies.

It would be more efficient and effective if municipalities could provide information targeting households with high electricity consumption among housewife households, which can be achieved through cooperation with electric power companies. Nonetheless, although the efficiency of the measure was reduced, it was also possible to provide information to all households in the municipality or to housewife households. One problem with using the HER is that providing information on the electricity consumption of others to households that are making progress in saving electricity may have a boomerang effect, causing an increase in electricity consumption (Knittel and Stolper, 2019).[18] It was assumed that the information on electricity price increases used in this study was unlikely to increase electricity consumption. Therefore, the risk of providing information to all households or housewife households is relatively small compared to using HER.

However, this study has the following three limitations. Therefore, generalizations of the results of this study should be considered. First, the intervention results were based on a monetary level of JPY

[18] It has also been shown that posting smiley face illustrations may reduce the boomerang effect (Schultz et al, 2007).

500/month (approximately $4.5). This study was not a scenario experiment but a social experiment based on actual conditions in Japan. Therefore, the results may vary at different monetary levels in different countries, regions, and periods. In this study, the amount of money was set at 500 yen, as it was necessary to equalize it in the two intervention groups. Given the current rise in electricity prices in Japan, 500 yen is a relatively small amount. In the intervention experiment, a long-term comparison, such as one or two years before, would have allowed for a larger price difference. It can be said that the intervention was effective even at the relatively low level of 500 yen, but further analysis at different monetary levels is needed.

Second, the study targeted housewives who were home during the daytime on weekdays in summer. These were chosen for the study because they were assumed to have large electricity reduction potential and opportunities to save electricity. The analysis showed intervention effects in the high electricity consumption group. It also affected specific behaviors, such as not leaving the air conditioner on. These results may also have implications for households that spend more time at home and consume more electricity because of the increase in telecommuting owing to the coronavirus pandemic. However, these are the results of an analysis of Japanese housewives who were at home during the daytime on weekdays in the summer. Therefore, further research is needed to determine the external validity of these results.

Third, the study focused on the short-term effects of summer and did not examine the long-term effects. Moreover, the short-term effects during winter have not been clarified. Therefore, the verification of these effects is required. However, to verify the mechanism of electricity consumption reduction, we also verified the effect of electricity-saving behavior, which, once implemented, has a long-lasting effect. The results showed that the intervention impacted the behavior of lowering the internal temperature of refrigerators. However, while information on Others was found to influence this behavior for all households, past information tended to influence those with high electricity consumption. These findings suggest that the information provided to promote electricity-saving behavior may differ according to electricity-saving behaviors and attributes. Further, each power-saving behavior and attribute needs validation.

In Japan, the price of electricity is expected to rise in the future owing to soaring fossil fuel prices and the ongoing debate on carbon pricing. Increasing fossil fuel prices is also a global phenomenon. Therefore, there is a strong need worldwide for measures to provide electricity price information with easy implementation by local governments, which can promote energy-saving behaviors in households. This study makes only a minor contribution to solving these problems. In the study of information provision, the setting of reference points to obtain effective results may vary depending on the field, target audience, and period. We believe this study will be useful for other research subjects as well, as a study to verify the effectiveness of information provision by devising reference points.

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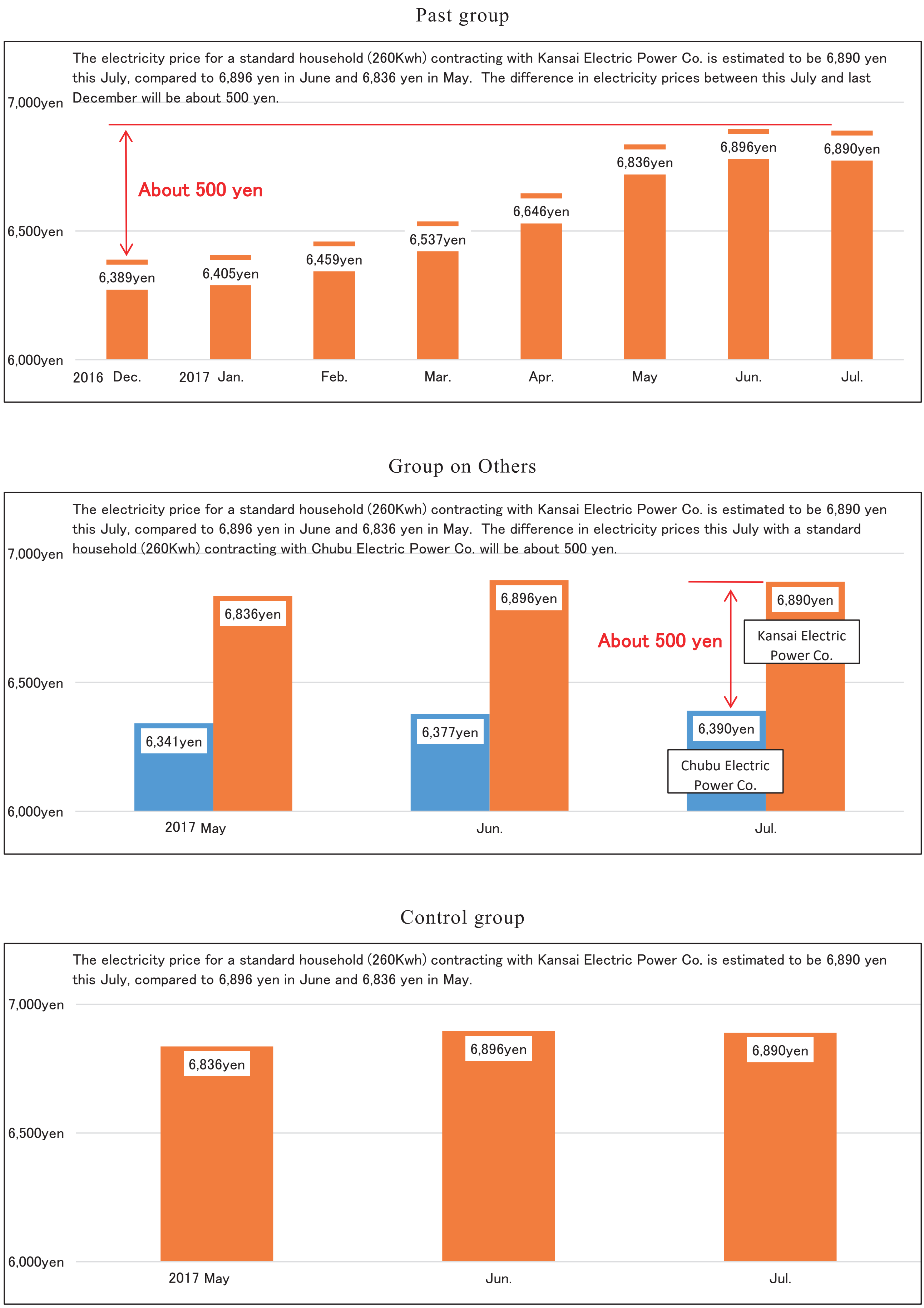

Fig. 1. The specific information provided for the three groups.

Table 1

Descriptive statistics and balance tests.

	Total	control group	Past group	group on Others	P-value (control-Past)	P-value (control-Others)
	(1)	(2)	(3)	(4)	(5)	(6)
Housing type	0.551	0.547	0.489	0.629	0.339	0.183
(detached houses=0, apartment buildings=1)	(0.498)	(0.500)	(0.502)	(0.485)		
Number of household members	3.086	3.058	3.129	3.069	0.547	0.929
	(1.005)	(0.991)	(0.999)	(1.036)		
Age	44.713	44.590	44.345	45.302	0.799	0.479
	(8.062)	(7.634)	(8.341)	(8.256)		
Annual household income (10,000 yen)	614.559	621.488	648.333	565.152	0.555	0.225
	(336.367)	(397.011)	(302.228)	(289.039)		
Awareness of retail electricity market deregulation	3.602	3.662	3.576	3.560	0.497	0.470
(1 to 6)	(1.089)	(1.053)	(1.063)	(1.167)		
Δ CCD (CCD2017 minus CCD2016)	2.753	1.584	5.106	1.334	0.170	0.927
	(21.603)	(21.207)	(21.447)	(22.198)		
Electricity2016 (kWh/day)	12.271	12.685	11.923	12.191	0.335	0.588
	(6.675)	(7.594)	(5.375)	(6.930)		
Ward						
Osaka	0.269	0.266	0.273	0.267	0.893	0.985
	(0.444)	(0.444)	(0.447)	(0.444)		
Mishima	0.160	0.158	0.180	0.138	0.633	0.650
	(0.367)	(0.366)	(0.385)	(0.346)		
Toyono	0.114	0.115	0.122	0.103	0.854	0.767
	(0.318)	(0.320)	(0.329)	(0.306)		
Kitakawachi	0.122	0.165	0.086	0.112	0.047 **	0.218
	(0.328)	(0.373)	(0.282)	(0.317)		
Nakakawachi	0.094	0.101	0.101	0.078	1.000	0.518
	(0.292)	(0.302)	(0.302)	(0.269)		
Minamikawachi	0.051	0.036	0.043	0.078	0.759	0.161
	(0.220)	(0.187)	(0.204)	(0.269)		
Senboku	0.127	0.101	0.144	0.138	0.274	0.366
	(0.333)	(0.302)	(0.352)	(0.346)		
Sennan	0.063	0.058	0.050	0.086	0.792	0.384
	(0.244)	(0.234)	(0.219)	(0.282)		
N	394	139	139	116		

Standard deviations in parentheses. Annual household income was 340 samples (control group: 121, Past group: 120, group on Others: 99), because 54 respondents don't know/don't want to answer the question about household income. The number of non-respondents is balanced across the three groups (control group: 18, Past group: 19, group on Others: 17). ***, ** and * indicate statistical significance at the 1%, 5%, 10% level, respectively.

Table 2

Analysis results of electricity consumption and willingness to change electricity companies.

	ΔY			Company change		
	(1)	(2)	(3)	(4)	(5)	(6)
Past	-0.256	-1.051	7.473	0.103	0.020	0.001
	(1.753)	(1.822)	(4.578)	(0.144)	(0.143)	(0.317)
Others	-0.620	-1.060	-2.707	-0.280 *	-0.271 *	-0.617 **
	(1.650)	(1.724)	(3.445)	(0.147)	(0.153)	(0.281)
Housing type		-2.458	-2.793 *		-0.082	-0.089
		(1.606)	(1.572)		(0.135)	(0.134)
Number of household members		2.144 **	2.276 **		0.260 ***	0.258 ***
		(0.864)	(0.829)		(0.066)	(0.065)
Age		-0.018	-0.044		0.000	-0.001
		(0.108)	(0.102)		(0.008)	(0.008)
Annual household income		0.000	0.000		0.000	0.000
		(0.002)	(0.002)		(0.000)	(0.000)
Awareness of retail electricity market deregulation		-0.074	-0.075		0.288 ***	0.293 ***
		(0.695)	(0.664)		(0.069)	(0.069)
ΔCCD		0.147 ***	0.140 ***		0.004	0.003
		(0.035)	(0.035)		(0.003)	(0.003)
Electricity2016		-0.541 ***	-0.433 **		-0.016 *	-0.026
		(0.154)	(0.154)		(0.009)	(0.016)
Past × Electricity2016			-0.713 **			0.001
			(0.321)			(0.023)
Others × Electricity2016			0.140			0.028
			(0.233)			(0.019)
Constant	2.253	4.392	4.469	2.803 ***	1.113 **	1.272 **
	(2.674)	(6.098)	(6.032)	(0.207)	(0.518)	(0.525)
Ward dummy	yes	yes	yes	yes	yes	yes
R^2	0.011	0.1447	0.1686	0.0441	0.1677	0.1726
N	394	340	340	394	340	340

Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5%, 10% level, respectively.

Table 3

Analysis results of time-consuming power-saving behavior.

	AC_28℃ (1)	AC_leave (2)	Fridge_stuff (3)	Fridge_leave (4)	TV_leave (5)	Light_leave (6)
Past	0.036	0.480 ***	0.173	0.061	0.083	0.211
	(0.186)	(0.164)	(0.154)	(0.150)	(0.158)	(0.146)
Others	0.145	0.314 *	-0.002	0.112	-0.129	-0.049
	(0.185)	(0.167)	(0.158)	(0.157)	(0.171)	(0.155)
Electricity2016	-0.040 ***	-0.044 ***	-0.019 *	-0.020 **	-0.028 ***	-0.022 **
	(0.010)	(0.009)	(0.010)	(0.009)	(0.010)	(0.009)
Constant	4.004 ***	2.917 ***	3.730 ***	2.942 ***	2.858 ***	2.638 ***
	(0.681)	(0.603)	(0.564)	(0.550)	(0.576)	(0.547)
Controls	yes	yes	yes	yes	yes	yes
Ward dummy	yes	yes	yes	yes	yes	yes
R^2	0.091	0.118	0.053	0.035	0.051	0.067
N	327	327	340	340	340	340

Robust standard errors in parentheses. The sample size for (1) and (2) is 327 because 13 respondents indicated that they "do not own/use air conditioners." Controls include Housing type, Number of household members, Age, Annual household income, Awareness of retail electricity market deregulation, and ΔCCD. ***, ** and * indicate statistical significance at the 1%, 5%, 10% level, respectively.

Table 4

Analysis results of time-consuming power-saving behavior (verification of heterogeneity).

	AC_28℃ (1)	AC_leave (2)	Fridge_stuff (3)	Fridge_leave (4)	TV_leave (5)	Light_leave (6)
Past	-0.270	0.136	-0.121	-0.125	-0.124	0.212
	(0.409)	(0.313)	(0.321)	(0.306)	(0.324)	(0.313)
Others	-0.011	0.268	-0.073	0.130	-0.277	0.206
	(0.324)	(0.301)	(0.311)	(0.287)	(0.309)	(0.268)
Electricity2016	-0.049 **	-0.051 ***	-0.027 *	-0.023 *	-0.036 **	-0.015
	(0.016)	(0.014)	(0.015)	(0.012)	(0.015)	(0.014)
Past × Electricity2016	0.025	0.028	0.024	0.015	0.017	0.000
	(0.030)	(0.021)	(0.023)	(0.021)	(0.025)	(0.023)
Others × Electricity2016	0.012	0.003	0.005	-0.002	0.012	-0.020
	(0.021)	(0.020)	(0.022)	(0.019)	(0.021)	(0.017)
Constant	4.092 ***	2.964 ***	3.786 ***	2.949 ***	2.942 ***	2.522 ***
	(0.692)	(0.608)	(0.585)	(0.560)	(0.607)	(0.569)
Controls	yes	yes	yes	yes	yes	yes
Ward dummy	yes	yes	yes	yes	yes	yes
R^2	0.093	0.122	0.055	0.037	0.052	0.070
N	327	327	340	340	340	340

Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5%, 10% level, respectively.

Table 5

Analysis results of hassle-free power-saving behavior.

	AC_outdoor unit				Fridge_cooling intensity				TV_energy-saving mode			
	(1)		(2)		(3)		(4)		(5)		(6)	
Past	0.013		-0.133		0.081		-0.108		0.024		0.113	
	(0.057)		(0.130)		(0.063)		(0.131)		(0.063)		(0.140)	
Others	0.002		-0.137		0.106	*	0.084		-0.067		-0.066	
	(0.058)		(0.124)		(0.063)		(0.118)		(0.067)		(0.131)	
Electricity2016	-0.008	**	-0.014	**	-0.006	*	-0.010	*	-0.004		-0.002	
	(0.004)		(0.006)		(0.004)		(0.005)		(0.004)		(0.006)	
Past × Electricity2016			0.012				0.016	*			-0.007	
			(0.010)				(0.009)				(0.010)	
Others × Electricity2016			0.011				0.002				0.000	
			(0.009)				(0.007)				(0.009)	
Constant	0.666	***	0.735	***	0.353		0.377		0.229		0.222	
	(0.198)		(0.207)		(0.224)		(0.230)		(0.218)		(0.227)	
Controls	yes		yes		yes		yes		yes		yes	
Ward dummy	yes		yes		yes		yes		yes		yes	
R^2	0.049		0.056		0.058		0.066		0.086		0.088	
N	327		327		340		340		340		340	

Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5%, 10% level, respectively.

Table A1

Analysis results of hassle-free power-saving behavior (probid analysis).

	AC_outdoor unit				Fridge_cooling intensity				TV_energy-saving mode			
	(1)		(2)		(3)		(4)		(5)		(6)	
Past	0.043		-0.438		0.209		-0.320		0.064		0.305	
	(0.191)		(0.443)		(0.175)		(0.370)		(0.171)		(0.387)	
Others	0.013		-0.435		0.298	*	0.239		-0.180		-0.186	
	(0.192)		(0.401)		(0.176)		(0.344)		(0.185)		(0.359)	
Electricity2016	-0.023	*	-0.043	**	-0.017	*	-0.029	*	-0.010		-0.005	
	(0.012)		(0.017)		(0.010)		(0.015)		(0.011)		(0.017)	
Past × Electricity2016			0.038				0.044	*			-0.020	
			(0.031)				(0.026)				(0.029)	
Others × Electricity2016			0.034				0.004				0.001	
			(0.025)				(0.022)				(0.025)	
Constant	0.367		0.571		-0.459		-0.395		-0.711		-0.730	
	(0.655)		(0.684)		(0.625)		(0.643)		(0.593)		(0.617)	
Controls	yes		yes		yes		yes		yes		yes	
Ward dummy	yes		yes		yes		yes		yes		yes	
Pseudo R^2	0.044		0.050		0.046		0.052		0.065		0.066	
N	327		327		340		340		340		340	

Coefficient is reported. Robust standard errors in parentheses. ***, ** and * indicate statistical significance at the 1%, 5%, 10% level, respectively.