Pre-Analysis Plan for "Encouraging Consumer Acceptance of Cost-Reflective Electricity Tariffs: Evidence from a Randomized Survey Experiment"

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Abstracts

Disconnect between the escalating costs of energy sources and the corresponding adjustments in electricity tariffs has become increasingly apparent in South Korea. When electricity prices are not cost-reflecting, this may distort electricity consumers' behaviors and increase operational risks of electricity companies. Thus, it is important to make electricity tariffs flexible enough to absorb cost fluctuation and to examine consumer preferences on cost-reflective electricity pricing. To this end, we conduct a randomized survey experiment to explore potential information interventions to enhance consumers' willingness to accept cost-reflective electricity tariffs. Furthermore, a conjoint experiment is supplemented to identify consumer preferences on the various attributes of cost-reflective electricity pricing.

Contents

Section1. Introduction

This pre-analysis plan presents the research hypotheses and specifications to examine the impacts of providing different types of information on the willingness to accept cost-reflective electricity tariffs. Our study consists of a randomized survey experiment and a conjoint experiment. For the survey experiment, we randomly provide information interventions that may affect consumers' willingness to accept cost-reflective electricity tariffs. The factors considered in the survey experiment are (1) cost salience (Kahneman et al., 1986; Gielissen et al., 2008; Renner and Tyran, 2004; Elias et al., 2022), (2) cross-product comparison, and (3) cross-country comparison (Xia et al., 2004; Malc et al., 2016). In the conjoint experiment, various attributes of cost-reflective electricity pricing structure are presented. The attributes include time lag between cost fluctuation and electricity tariff adjustment, frequency of cost information disclosure, regional differentiation in electricity tariffs, and the extent of electricity rate increases.

The pre-analysis plan is structured as follows: Section 2 describes the study design, the sample used in this study, and the data to be collected for this research. In Section 3, we outline the research questions and the specifications for data analysis. This research was approved by the Institutional Review Board (IRB) through Seoul National University (IRB No. 2402/003-007).

Section 2. Study Design

2.1 Sample Selection

We plan to survey approximately 3,500 electricity consumers in South Korea, including 1,000 residential consumers, 1,000 general consumers, and 1,500 industrial consumers. The survey targets consumers who are capable of decision-making regarding electricity consumption, where residential consumers are adults aged 19 and above, while general and industrial consumers are individuals authorized to make electricity consumption decisions within their businesses. Additionally, general and industrial consumers were stratified and selected based on the annual electricity usage of their businesses.

2.2 Sources of Data

The primary data source is an online survey. The survey questionnaires inquire about the respondents' (i) socioeconomic characteristics, (ii) electricity-related knowledge, (iii) perceptions concerning electricity-related issues, and (iv) preferences regarding various electricity pricing schemes.

2.3 Experiment

To investigate the factors influencing consumers' willingness to accept cost-reflective electricity tariffs, we design a randomized survey experiment with information treatment. Respondents stratified by consumer type (residential, general, and industrial) are randomly assigned into one control group and three treatment groups. The control group receives no information, while the treatment groups are provided with the following information:

i) Information emphasizing that electricity rates are not cost-reflective (cost salience).

ii) Information comparing electricity rates to more flexibly moving gasoline prices (cross-product comparison).

iii) Information indicating that electricity rates in South Korea are more rigid than those of other countries (cross-country comparison).

After the information treatment is provided, respondents answer the following questions:

i) What proportion of the change in cost for electricity production do they think is willing to accept?

ii) What percentage of this change do they believe should be fair for consumers to bear?

Subsequently, various attributes constituting the cost-reflective electricity pricing system (such as time lag between cost fluctuation and electricity tariff adjustment, frequency of cost information disclosure, regional differentiation in electricity tariffs, and the extent of electricity rate increases) are randomly combined in different configurations. When presented with pairs of different electricity rate systems, respondents are asked to choose the electricity rate system they prefer in each pair.

Section 3. Research Questions and Estimation

3.1 Research Questions

One of the primary research questions in this study is to investigate whether and to what extent providing information about the inflexibility of electricity tariffs can enhance the willingness to accet cost-reflective electricity tariffs.

Research Question 1: Do respondents in the treatment groups exhibit a greater propensity to accept cost-reflective electricity tariffs compared to respondents in the control group?

Furthermore, we intend to explore subsequent questions regarding the preferences for attributes of cost-reflective electricity tariffs.

Research Question 2: What are consumer' preferences regarding price-related factors among the attributes of cost-reflective electricity tariffs?

3.2 Survey Experiment

3.2.1 Balance Test

First, we will conduct mean comparison tests and regression analyses in order to check the balance among four groups in experiment – one control and three treatment groups in terms of basic socioeconomic characteristics.

3.2.2 Average Treatment Effects

We estimate the average treatment effects using an OLS specification given below.

$$y_i = \beta_0 + \sum_{j=1}^{3} \beta_j Treatment_i^j + \boldsymbol{X}_i \boldsymbol{\gamma} + \epsilon_{i,}$$

where y_i denotes outcome variables of a respondent i, $Treatment_i^j$ denotes a dummy variable indicating whether a respondent i receives a treatment j, $j = 1,2,3$. $\boldsymbol{X}_i$ is a vector of controlling covariates including respondent i's socioeconomic and other characteristics. Finally, ϵ_i denotes an error term. The coefficient of $Treatment_i^j$, β_j captures the average treatment effect for each information treatment.

3.2.3 Heterogeneous Treatment Effects

In this study, we also aim to estimate heterogeneous treatment effects through an equation that includes interaction between treatment status and variables of interest for heterogeneity. We consider three main dimensions for possible heterogeneous treatment effects: 1) level of electricity knowledge, 2) political orientation, and 3) level of trust in KEPCO.

3.3 Conjoint Experiment

Based on a random utility framework, we estimate the effect of each attribute level on the respondent's electricity tariff choice probability using the following specification below.

$$\begin{aligned} U_{ni} = {} & \beta_{n,imd} D_{n,imd} + \beta_{n,3ma} D_{n,3ma} + \beta_{n,3ty} D_{n,3ty} + \beta_{n,3ny} D_{n,3ny} + \beta_{n,tny} D_{n,tny} \\ & + \beta_{n,1mo} D_{n,1mo} + \beta_{n,3mo} D_{n,3mo} + \beta_{n,6mo} D_{n,6mo} + \beta_{n,trans} D_{n,trans} \\ & + \beta_{n,5won} D_{n,5won} + \beta_{n,10won} D_{n,10won} + \beta_{n,25won} D_{n,25won} + \beta_{n,cost} x_{n,cost} \\ & + \epsilon_{ni} \end{aligned}$$

U_{ni} denotes the utility of choice alternative i for individual n. Righthand side consists of dummy coded variables for each attribute-level. One level for each attribute is set as a reference point and omitted from the equation. $x_{n,cost}$ denotes the cost vector and ϵ_{ni} is an error term.

First, variables $D_{n,imd}$, $D_{n,3ma}$, $D_{n,3ty}$, $D_{n,3ny}$ and $D_{n,tny}$ denote the time lag before cost fluctuations to be reflected in electricity price. $D_{n,imd}$ is a dummy variable for reflecting all cost changes within a single month. $D_{n,3ma}$, $D_{n,3ty}$ $D_{n,3ny}$ and $D_{n,tny}$ indicate reflecting all cost changes within three months, reflecting 50% of cost changes within three months and remaining 50% this year, reflecting 50% of cost changes within three months and remaining 50% the following year, and reflecting 50% of cost changes this year and remaining 50% within the following year, respectively.

Second, variables $D_{n,1mo}$, $D_{n,3mo}$ and $D_{n,6mo}$ denote the frequency of disclosing electricity costs. $D_{n,1mo}$, $D_{n,3mo}$, $D_{n,6mo}$ indicate a dummy variable for monthly, trimestral and half-yearly disclosure, respectively.

Third, $D_{n,trans}$ is a dummy variable which indicates whether regional transmission costs are imposed.

Fourth, variables $D_{n,5won}$, $D_{n,10won}$ and $D_{n,25won}$ denote the maximum difference of electricity price between regions. $D_{n,5won}$ indicates an upper limit of 5 Korean won per

1 kilowatt hour of electricity use(1kWh). $D_{n,10won}$ and $D_{n,25won}$ denote a limit of 10 Korean won and 25 Korean won per kWh, respectively.

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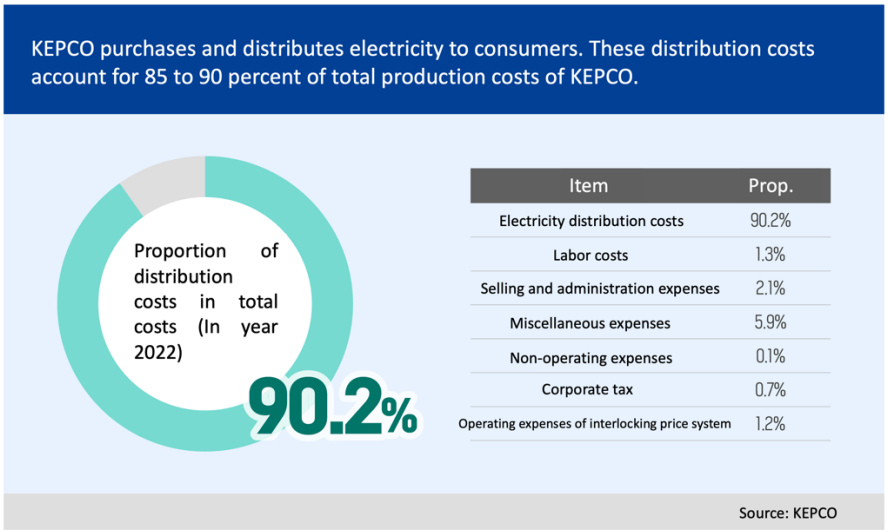
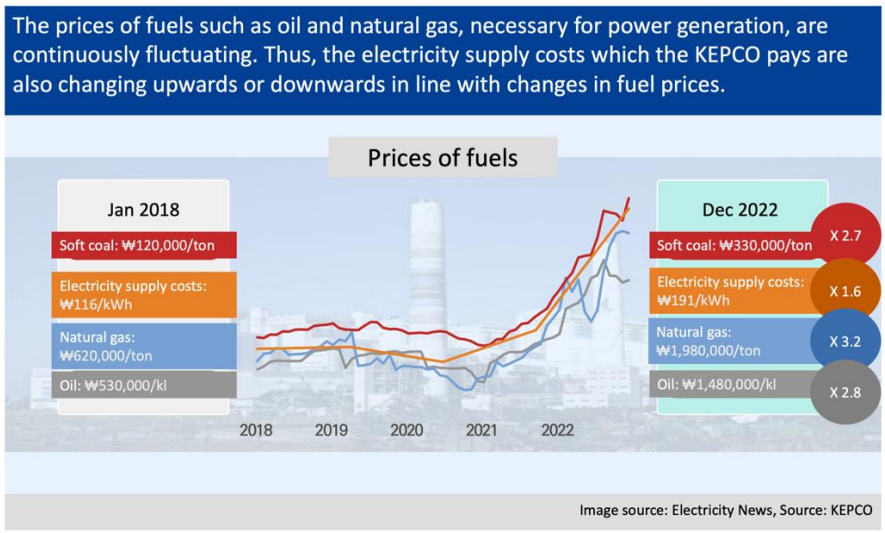
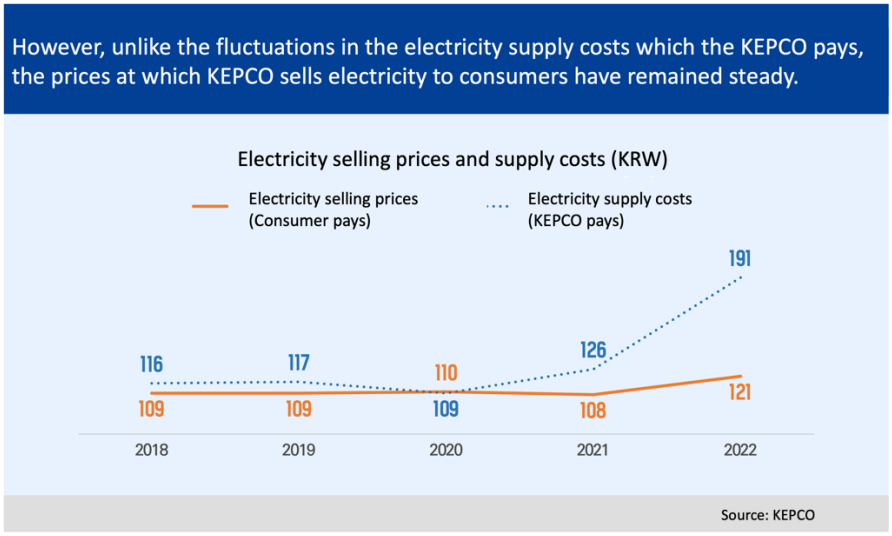
APPENDIX

A. Images of Information Treatments

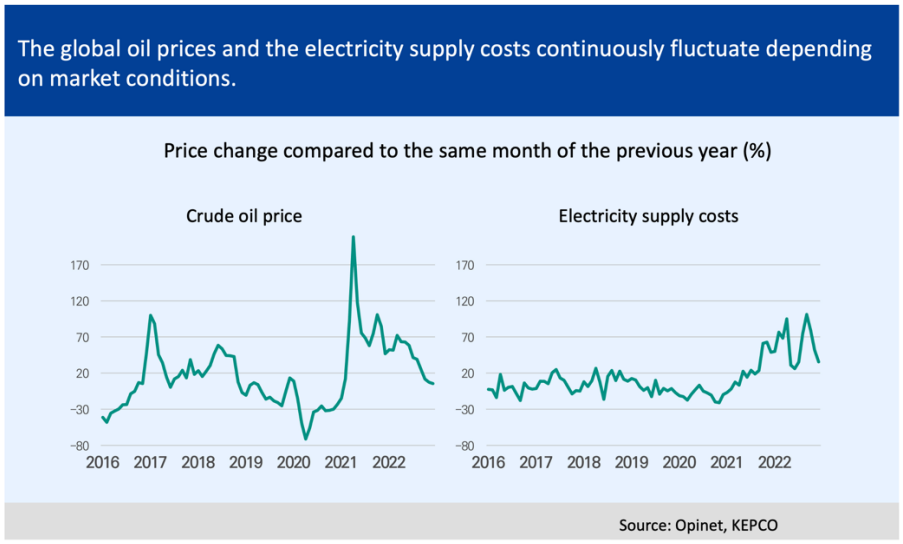
(1) Treatment 1. Cost salience

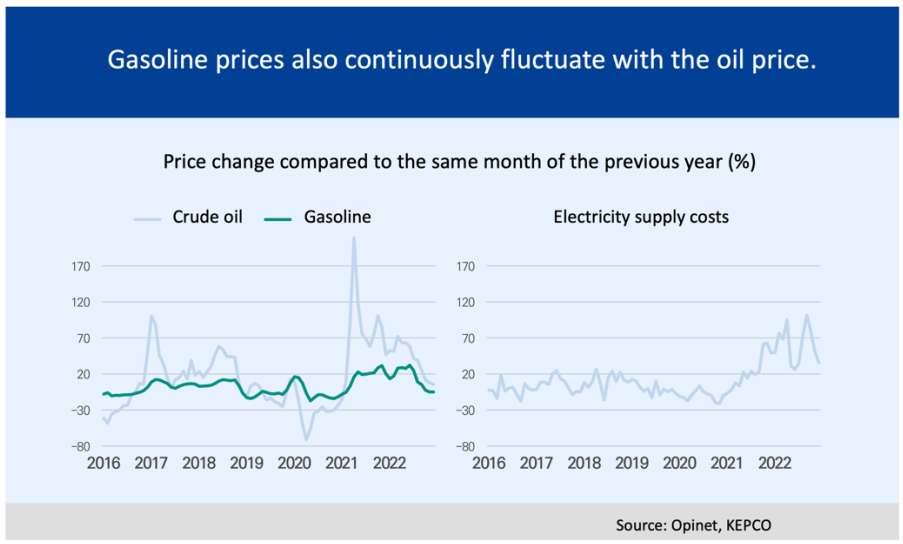


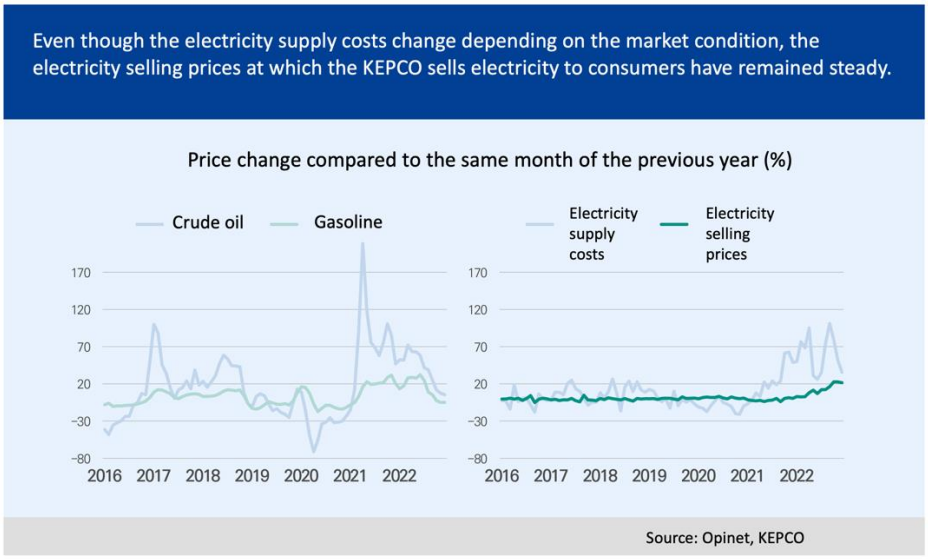




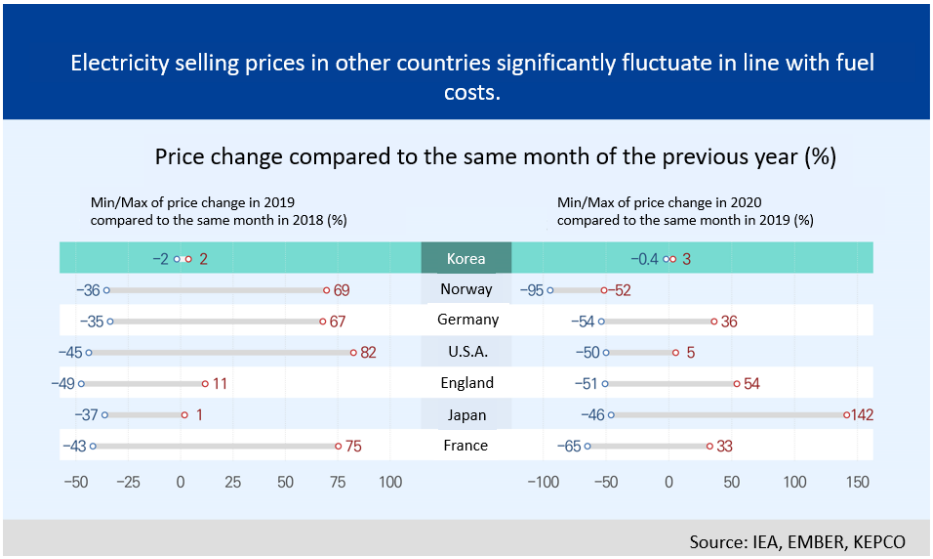
(2) Treatment 2. Cross-product comparison

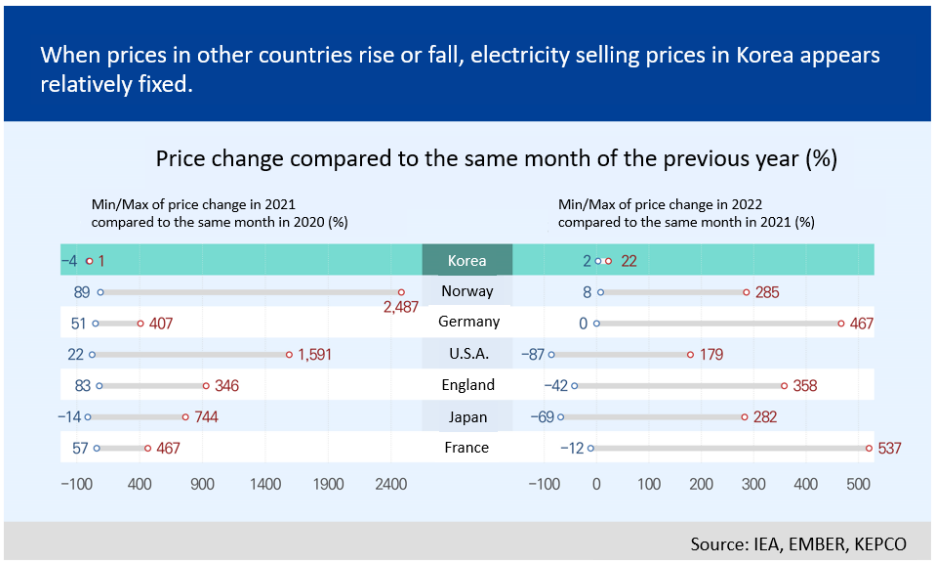






(3) Treatment 3. Cross-country comparison





B. Survey Questionnaire of the Main Outcome Variables

(1) Willingness to accept the price changes when the price increases

In a particular year, the electricity supply costs per kWh increased by 100 KRW due to the increase in fuel costs. How much would you be willing to accept the increase in the following year? (Including the costs in your electricity prices means the electricity rates will increase by the amount of the cost × usage (kWh). If all 100 KRW is fully included in the price, the monthly electricity costs would be increased by approximately 33,000 KRW for a 4-person household and 31,000 KRW for a 2-person household.

(2) Willingness to accept the price changes when the price decreases

In a particular year, the electricity supply costs per kWh decreased by 100 KRW due to a drop in fuel costs. How much would you be willing to accept the decrease in the following year? (Including the costs in your electricity prices means the electricity rates will decrease by the amount of the cost × usage (kWh). If all 100 KRW is fully included in the price, the monthly electricity costs would be decreased by approximately 33,000 KRW for a 4-person household and 31,000 KRW for a 2-person household.

(3) Fair Distribution of Prices

In a particular year, the electricity supply costs per kWh changed (increased or decreased) by 100 KRW due to a change in fuel costs. For example, the monthly electricity costs would be decreased by approximately 33,000 KRW for a 4-person household and 31,000 KRW for a 2-person household on average. How do you think it would be fair to allocate this costs?

1) Current consumers	%
2) Future consumers	%
3) Goverment	%

C. List of Attributes of Conjoint Experiment

(1) **Time Lag Between Cost Fluctuation and Electricity Rate Change** The first attribute describes whether changes in electricity production cost are materialized relatively shortly or smoothed out with some time lag in electricity bills. To increase the awareness of financial costs incurred when postponing an electricity tariff change, a short notice that reads "*Additional financial cost including interest rates incurred*" was displayed for all attribute levels except the first level (Reflect 100% within this month). See Example of Choice Set Below.

(2) **Frequency of Cost Disclosure** The second attribute varies the frequency of disclosing the electricity production cost to the public.

(3) **Regional Transmission Costs** The third attribute describes whether the additional cost of transmitting electricity to each region is added to the bill.

(4) **Maximum Electricity Rate Difference Between Regions** The fourth attribute describes the difference in electricity rates between region with the highest electricity tariff and the lowest electricity tariff.

(5) **Electricity Rate Increase Compared to Current Bill** The last attribute denotes the increase in electricity bill compared to the respondent's current bill.

Attributes	Levels					
1. Time Lag Between Cost Fluctuation and Electricity Rate Change	Reflect 100% within this month	Reflect 100% within 3 months	Reflect 50% in 3 months, 50% within this year	Reflect 50% in 3 months, 50% within next year	Reflect 50% in this year, 50% within next year	Reflect 100% in next year
2. Frequency of Cost Disclosure	1 month	3 months		6 months		1 year
3. Regional Transmission Costs	Imposed			Not Imposed		
4. Maximum Electricity Rate Difference Between Regions	5 won per kWh	10 won per kWh		25 won per kWh		50 won per kWh
5. Electricity Rate Increase Compared to Current Bill	5%	10%	15%	20%		25%

D. Example Choice Set of Conjoint Experiment

	Electricity Tariff A	Electricity Tariff B
1. Time Lag Between Cost Fluctuation and Electricity Rate Change	Reflect 100% within this month	Reflect 100% within 3 months (with additional financial cost of interest rates)
2. Frequency of Cost Disclosure	Every 3 months	Every 6 months
3. Regional Transmission Costs	Not Imposed	Imposed
4. Maximum Electricity Rate Difference Between Regions	25 won per kWh	5 won per kWh
5. Electricity Rate Increase Compared to Current Bill	15%	10%
Choice	□	□