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# **Correlation analysis of Environmental actions, Environmental consciousness, and Recognition of environmental labels**

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## **Abstract:**

The purpose of our research is to clarify the relationship between environmental actions, environmental consciousness, and the extent to which environmental labels are recognized. There are significant differences in the individual perception of environmental problems, and it is important to encourage environmental actions while taking into consideration these differences. Then in this research, we assumed a relationship between actions that are conscious of environmental problems (environmental actions), and the extent to which commonly known environmental labels are recognized, and how consciousness of environmental problems fluctuates high or low (environmental consciousness); and conducted an online questionnaire survey to investigate these issues. To illustrate concrete environmental actions, we took advantage of the registration for energy visualization provided by a power company (through the “electric household account book), and efforts to reduce electricity usage (reduction efforts) and the agreement on power peak shift (peak shift agreement).

From the questionnaire result, we found that environmental actions are influenced by environmental consciousness, and differences in the extent to which environmental labels are recognized. We are able to explore the possibility of inducing environmental actions not only for consumers with high environmental consciousness, but also to others by using effective ways of explaining new concepts, etc. Therefore, we intend to examine the relationship between environmental actions, the mechanism of providing information, and how this information is understood by conducting a new survey.

**JEL Classifications:** Q50, Q40, R29

## **Key Words:**

Environmental Actions, Environmental Consciousness, Recognition of Environmental Labels, Electric Household account book, The Peak Shift of Electric Power, Questionnaire Survey, Intervention of Information, HEMS

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## 1. Introduction

Environmental problems are ones shared by humanity as a whole. There are significant differences in the individual perception of environmental problems, and it is important to encourage environmental actions while taking into consideration these differences. For that reason, it is necessary to grasp how differences in consciousness of environmental problems generate differences in perception, and what kind of different environmental actions they provoke. In this research, we assumed a relationship between actions that are conscious of environmental problems (environmental actions), and the extent to which commonly known environmental labels are recognized, and how consciousness of environmental problems fluctuates high or low (environmental consciousness); and conducted an online questionnaire survey to investigate these issues.<sup>1</sup>

To illustrate concrete environmental actions, we took advantage of the registration for energy visualization provided by a power company (through the “electric household account book<sup>2</sup>”), and efforts to reduce electricity usage (reduction efforts) and the agreement on power peak shift (peak shift agreement). We examined the motivation of environmental actions, i.e., fluctuation in the perception of environmental problems, specific interests in environmental problems (environmental consciousness) or the recognition of environmental labels (environmental labels recognition).

The purpose of this research is to clarify the relationship between environmental actions, environmental consciousness, and the extent to which environmental labels are recognized. Based on the results, further insights into factors leading to environmental actions are presented. The existing literature presents many studies that analyze consumer preferences towards a low-carbon society, such as Goto and Ariu (2010); and studies that analyze the effect of environmental labels themselves, such as Asano (2013). This study focuses on the relationship between environmental actions, environmental consciousness, and the extent to which environmental labels are recognized. There are no previous studies that examine electric household account books, and this is the first study where information on the peak shift of electric power was provided (intervention of information), and its impact measured. Thus, the significance of this study is that we tackled the issue from a new perspective.

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<sup>1</sup> This survey was conducted under a grant-in-aid for scientific research (issue number: 26870638).

<sup>2</sup> This is a service offered free of charge by the Tokyo Electric Power Co., Inc. (currently TEPCO Energy Partner) website. By registering, consumers can compare electricity usage at home with the previous year, and browse through energy saving advice, etc.

The structure of the remainder of the paper is as follows. Chapter 2 presents the outline of the questionnaire survey and the analysis methodology. Chapter 3 describes the results of the questionnaire. Based on the results presented in Chapter 3, Chapter 4 presents the analysis based on attributes, the results of cross tabulation, correlation analysis, and principal component analysis of the relationship between environmental actions, environmental consciousness, and the extent to which environmental labels are recognized. Chapter 5 offers concluding remarks.

## 2. Survey and analysis methodology

In this study, we assume that environmental actions, such as energy reduction efforts by consumers, are affected by environmental consciousness and a difference in perception of environmental problems by the extent to which environmental labels are recognized (Figure 1). An online questionnaire survey was conducted to investigate the environmental actions of consumers, and their recognition of environmental problems (Table 1).



Figure 1. Relationship between environmental actions and perception of environmental problems

In the questionnaire survey, we targeted one metropolis and six prefectures in the area<sup>3</sup> serviced by Tokyo Electric Power Company (TEPCO) to investigate the registration status of the electric household account book, which we consider an ‘environmental action’. A screening survey was carried out beforehand to 2,390 monitors. In the screening survey, the nationwide monitors registered with the company were screened based on the following criteria:

- Resides in target area (one metropolis and six prefectures serviced by TEPCO)
- Head of household or spouse
- Employed or retired individuals (students were not included)
- Check electricity consumption themselves
- Resides in a house where the Housing Energy Management System (HEMS) has not yet

<sup>3</sup> This corresponds to Tokyo, Chiba, Saitama, Kanagawa, Gunma, Tochigi, and Ibaraki.

been installed

The recovered samples were 1,036, and the recovery rate was 43.4%. Work such as data cleaning was performed, and 851 samples were extracted as the data to be analyzed. Regarding the number of questions, there were 3 questions in the screening survey, 25 questions in the main survey, and the maximum number of questions answered by one person was 23.

Table 1. Outline of the survey

Name of survey	Online questionnaire survey about Environmental consciousness
Survey method	Online questionnaire survey
Survey Agency	Macromill,INC.
Date of survey	【Screening survey】from March 28, 2016 16:55 to March 30, 2016 【Main survey】March 30, 2016
Target of questionnaire	Resides in target area(one metropolis and six prefectures serviced by TEPCO) Head of household ore spouse Employed or retired individuals(students were not included) Checd electricity consumption themselves Residers in a house where the Housing Energy Management System(HEMS) has not yet been installed
Survey items (questionnaire)	【Screeninf survey】 Installed equipment that can see electricity consumption, operation of the water heater at home Confirmer of the electric bill(consumption) Contract with TEPCO and registered for TEPCO's electric household account book 【Main survey】 Registered for the electric household account book and registration date Frequency of checking the electricity consumption Changes in Behavior and Electricity Consumption after registered the electric household account book Check the screen presentation about energy-saving technology and smile marks Means for checking the monthly electricity charge Interest in environmental items Effort to reduce electricity consumption Recognition of environmental labels Intervention of information The attributes of responders(number of chiledren, the size of residence, and average time of staying at home per day) Change behavior with the liberalization of electric power

For the analysis, the number of environmental labels that were recognized by the respondent was taken as degree of recognition, and for environmental consciousness and environmental actions, variables were prepared by quantifying (assigning points to) responses from multiple questions. In the analysis, first, we summarized the data characteristics by simple tabulation and cross tabulation, and analyzed the correlation between environmental actions, environmental consciousness, and the extent to which environmental labels were recognized. In addition, a scatter diagram was created with the principal component score

obtained by the principal component analysis, and the relationship between each variable was analyzed.

### 3. Results of the questionnaire survey

The attributes of respondents were as follows: average age of 51.2 years, average residence period of 14.3 years, average number of children living together of 0.7 children, average residential area of 85.0 m<sup>2</sup>, and average time of staying at home per day was 17.4 hours (Table 2).

Table 2. Outline of respondent attributes

Sample size	851
Average age(age)	51.2
Average residence period(year)	14.3
Average number of children living together(person)	0.7
The size of residence(m <sup>2</sup> )	85
Average time of staying at home per day(hour)	17.4

#### 3.1 Environmental actions

We investigated the actual energy reduction efforts for the respondents. In addition, as environmental actions, we investigated the status of registration for the electric household account book, and the comprehension of the explanation about peak shift agreements.

##### (1) Energy reduction efforts

We investigated energy reduction efforts through multiple answers for each household appliance. The survey included 18 actions related to six home electronic appliances (air conditioner, lighting, vacuum cleaner, refrigerator, dishwasher, and the electric washing toilet seat) (Table 3).

Of the 18 actions, those with the highest degree of effort reported by respondents were 67.2% for “air conditioning: reduce usage time,” then 57.8% for “air conditioning: adjust temperature setting and wind direction,” and 50.4% for “refrigerator: open and close the door

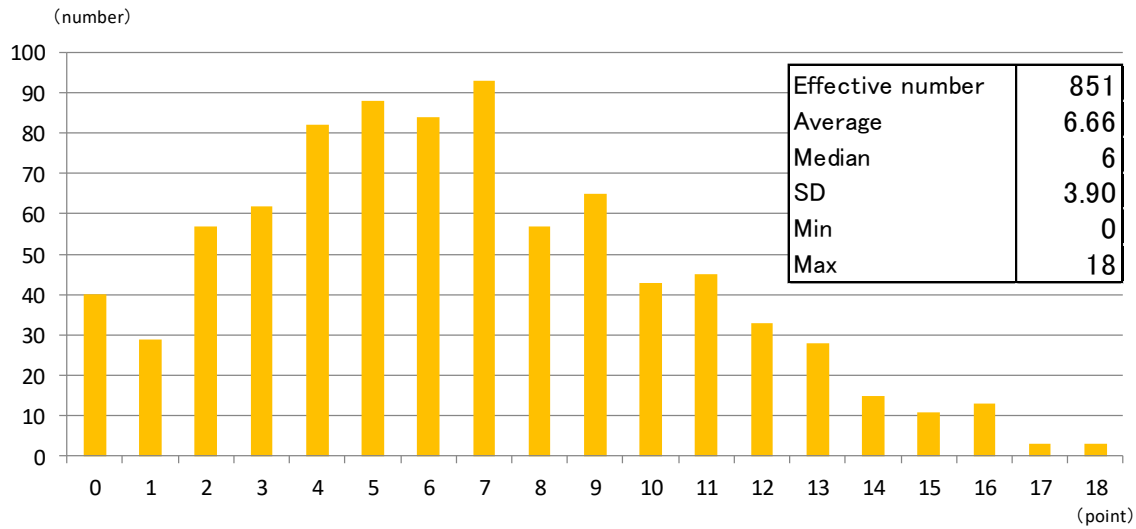
less and for shorter time periods.” More than 40% of respondents indicated that they were taking action on saving energy by either “air conditioning: cut heat intrusion with curtains, blinds, etc.,” “lighting: switch to lamps with low power consumption,” “refrigerator: adjust the temperature setting inside the refrigerator,” and “electric washing toilet seat: close the lid.” “Dishwasher: thinking about placement of dishes” had the lowest ratio of 7.4%, but this may likely be due to the fact that many respondents did not have a dishwasher, so this figure needs further scrutiny.

Figure 2 shows the number of responses in 18 actions and its conversion into points. The minimum observed score was zero points, the maximum was eighteen points, and the average was 6.7 points.

Table 3. Power saving actions (multiple answers were allowed)

		N	%
Air conditioner	Adjust the temperature setting and wind direction	492	57.8
	Reduce usage time	572	67.2
	Cut heat intrusion with curtains and blinds	396	46.5
	Frequently clean filters	272	32.0
Lighting	Utilize the light control function (adjustment of lighting)	213	25.0
	Switch to low power consumption lamps	397	46.7
Vacuum cleaner	Ensure cleanliness and tidiness of rooms before use	266	31.3
	Use switches properly according to flooring materials	147	17.3
	Frequent care of rotating brush	144	16.9
Refrigerator	Adjust temperature setting inside	359	42.2
	Ensure cleanliness and tidiness of the interior	334	39.2
	Cool hot things before putting them in	448	52.6
	Open and close the door less and for shorter time periods	429	50.4
Dishwasher	Wash only when dishwasher is full	259	30.4
	Think about placement of dishes	63	7.4
Electric washing toilet seat	Use the power saving/timer function	201	23.6
	Close the lid	345	40.5
	Adjust the temperature setting (not use it in summer)	329	38.7
No actions applies to me		40	4.7

Figure 2. Points for energy reduction efforts



(2) Electric household account book

When we asked respondents whether they were registered for an electric household account book, 52.8% responded positively (registered) and 47.2% responded negatively (unregistered) (Table 4).

Table 4. Status of registration for an electric household account book

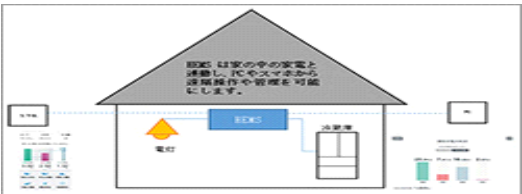


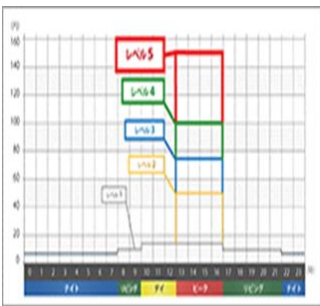
	N	%
Registered	449	52.8
Not Registered	402	47.2
Total	851	100.0

(3) Peak shift agreement

In investigating the peak shift agreement, we asked questions about the level of comprehension of the Home Energy Management System (HEMS) with the peak shift function using four explanations with diagrams as indicated below (Figure 3).



Figure 3. Contents provided in each explanation of the HEMS

Explanation 1	Explanation 2
<p>When installing the so-called HEMS equipment in the house, it is possible to do various things in conjunction with home electric appliances and solar power generation equipment etc.</p>  <p>(Source) Adjusted drawings from the Mitsubishi Electric's website.</p>	<p>For example, it is possible to display power consumption (= visualizing) every hour with graphs, etc. This makes it easy for people to know how to save energy use, which may lead to energy conservation.</p>  <p>(Source) Adjusted drawings from the TOYOTA' website.</p>
Explanation 3	Explanation 4
<p>By using smartphones etc. away from your house, you can check the presence or absence of electricity use. As a result, you can see the situation inside the house such as “when the light switches were turned on,” “when the electric kettle was used.” It is possible to monitor elderly parents who are far away or children who are staying at home.</p>  <p>(Source) Adjusted drawings from the Mitsubishi Electric's website.</p>	<p>It is also expected that diversification of the price menu will be accompanied by the liberalization of electric power in the future. For example, at peak time, the setting of the electricity charge will be set extremely high. The setting of actual electricity charges in Kitakyushu city is 15 yen/kWh in Level 1, but it reaches 150 yen/kWh for Level 8 when the electrical power is in a strained situation.</p>  <p>(Source) Adjusted drawings from the New Energy Promotion Council' website.</p>

In Explanation 1, we introduced the term, HEMS, and explained that when HEMS is installed in the house, various things can be done in conjunction with home appliances and solar power generation equipment. In Explanation 2, we introduced the “visualization” function (of energy consumption) as one of the things that can be achieved with HEMS.

HEMS can display electric power consumption per hour; it allows consumers to figure out how they can save energy and thus creates a potential energy savings effect. In Explanation 3, we introduced the “monitoring” function for the family. Through the use of devices such as smartphones, it is possible to know the presence or absence of electricity use from outside the house, e.g., time when the light switch was turned on, when electric pots were used. This makes it possible to check the safety of elderly parents or children staying at home. In Explanation 4, we introduced the diversification of the electricity rate menu due to the liberalization of electric power based on the case in Kitakyushu city, and explained that the HEMS controls the optimum energy usage, and automatically shifts peaks in such a case.

There were 7 choices regarding the level of comprehension of these explanations: “I was able to understand it very well,” “I was able to understand it well,” “I was able to understand it somewhat,” “no opinion,” “I was not able to understand it somewhat,” “I was not able to understand it well,” and “I was not able to understand it at all.” The most frequent response was “I was able to understand it somewhat” with 45.5%, followed by “no opinion” with 20%, and “I was able to understand it well” with 16.2%. “I was able to understand it very well,” “I was able to understand it well,” and “I was able to understand it somewhat” accounted for 64.3% of the total, while 15.8% answered either “I was not able to understand it somewhat,” “I was not able to understand it well” or “I was not able to understand it at all.” (Table 5).

Table 5. Comprehension of the HEMS explanation

	N	%
I was able to understand it very well	22	2.6
I was able to understand it well	138	16.2
I was able to understand it somewhat	387	45.5
No opinion	170	20.0
I was somewhat unable to understand	63	7.4
I was not able to understand it well	49	5.8
I was not able to understand it at all	22	2.6
Total	851	100.0

After presenting the explanation, we asked respondents whether they would like to introduce the HEMS with peak shift function to their houses. The percentage of people who would like to purchase it for a fee was as low as 1.9%, but if it was free, the percentage jumped to 59.2%, which was the most common answer. Meanwhile, “no opinion” was 27.7% (Table 6).

Table 6. Intent to introduce the HEMS with peak shift function

	N	%
Even if there were a fee, I would buy it and use it	16	1.9
I would use it if it were free	504	59.2
No opinion	236	27.7
I would not use it even if it were free	95	11.2
Total	851	100.0

### 3.2 Environmental consciousness

We asked all respondents their level of interest in 23 environmental items using a five-point scale (“it applies to me,” “it applies to me to a considerable degree,” “no opinion,” “it applies to me to some degree,” and “it does not apply to me”). We took “(a) Energy and Environment Consciousness” (Figure 3-1 and Appendix 1) and “Summarization of Explanatory Variables” (Attached Table 2) of Goto and Ariu (2010) as reference, and created 23 items within 8 environmental interest areas.

Table 7 shows the results. First, when examined by field of environmental interest areas, there are many responses of “no opinion” in “function/convenience-orientation,” “degree of interest in global environment” and “lack of global environment information.” In the environmental interest areas “degree of practicality of energy saving,” “lack of energy saving information” and “energy/environment consciousness,” many responses indicated, “it applies to me to a considerable degree.” On the other hand, in the area of “degree of involvement with new products,” the share of the responses “it applies to me to some degree” and “it does not apply to me” is quite high.

More than 40% of respondents answered “it applies to me to a considerable degree” for the following six items: “global environmental problems are a major problem in the 21st century,” “I frequently turn off lights,” “information on types and prices of energy-saving home appliances are insufficient,” “it is hard to know which devices should be replaced with energy saving home appliances,” “it is difficult to know the environmental improvement effect of energy saving actions,” and “policies to promote voluntary energy saving by consumers is important.” For the item “electricity and gas company provided information on

global environmental issues is insufficient,” the majority of the responses were “no opinion.” A third of respondents answered, “it applies to me to some degree” to “I often read magazine advertisements about the release of new home electronic products.” More than 40% responded “it does not apply to me” to the item “I often read magazine advertisements about the release of new vehicles,” and “I often purchase new home electronic products before other people.” On the other hand, the following items received the highest proportion of “it applies to me”: “when shopping, I bring a recycle bag and do not use the shop’s plastic bags” (33%), followed by “I frequently turn off the lights” (29%).

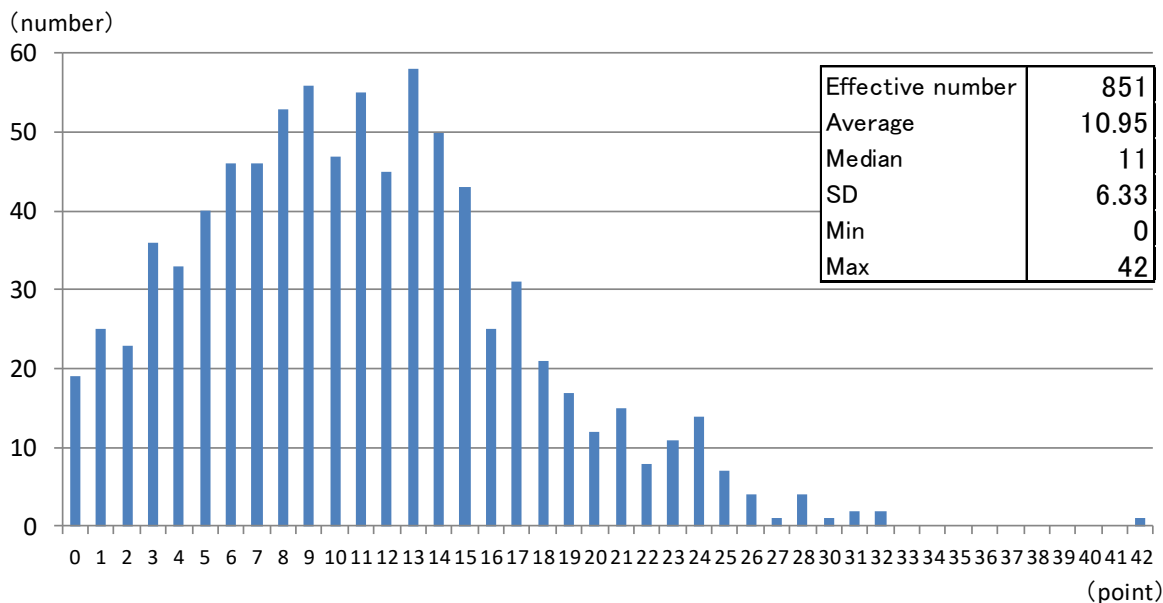
Table 7. Responses on items categorized by environmental interest areas

Field		It applies to me	It applies to me to a considerable degree	No opinion	It applies to me to some degree	Does not apply to me	Total %
Functions and convenience	I place more importance on the functions and convenience of home electronic appliances rather than energy saving	27	206	372	207	39	851
	I place more importance on the functions and convenience of vehicles rather than fuel consumption and environmental impact	3.2	24.2	43.7	24.3	4.6	100.0
	I place more importance on the functions and convenience of vehicles rather than fuel consumption and environmental impact	3.3	15.5	34.8	21.4	10.1	851
	I place more importance on the functions and convenience of vehicles rather than fuel consumption and environmental impact	3.9	18.2	40.9	25.1	11.9	100.0
Involvement with new products	I often read magazine advertisements about the release of new home electronic products	13	100	177	286	275	851
	I often read magazine advertisements about the release of new vehicles	1.5	11.8	20.8	33.6	32.3	100.0
	I often read magazine advertisements about the release of new vehicles	13	75	143	231	389	851
	I often purchase new home electronic products before other people	1.5	8.8	16.8	27.1	45.7	100.0
	I often purchase new home electronic products before other people	5	49	151	287	359	851
Using Internet	I use the latest functions of home electronic appliances	0.6	5.8	17.7	33.7	42.2	100.0
	I use the latest functions of home electronic appliances	15	77	291	263	205	851
	I gather information about home electronic appliances mainly from the internet	1.8	9.0	34.2	30.9	24.1	100.0
	I gather information about home electronic appliances mainly from the internet	127	331	202	108	83	851
Environmental interest	I purchase home electronic appliances mainly through the internet	14.9	38.9	23.7	12.7	9.8	100.0
	I purchase home electronic appliances mainly through the internet	43	120	267	212	209	851
	I purchase home electronic appliances mainly through the internet	5.1	14.1	31.4	24.9	24.6	100.0
	I often read newspaper articles and books on global warming	23	130	273	243	182	851
Energy saving	I am concerned about our dependence on fossil fuels	2.7	15.3	32.1	28.6	21.4	100.0
	I am concerned about our dependence on fossil fuels	37	216	332	158	108	851
	I am concerned about our dependence on fossil fuels	4.3	25.4	39.0	18.6	12.7	100.0
	Global environmental problems are important problems in the 21st century	159	355	228	64	45	851
Lack of information on global environmental issues	Global environmental problems are important problems in the 21st century	18.7	41.7	26.8	7.5	5.3	100.0
	I frequently turn off lights	251	409	134	42	15	851
	I frequently turn off lights	29.5	48.1	15.7	4.9	1.8	100.0
	I use public transport when going shopping	176	191	211	154	119	851
	I use public transport when going shopping	20.7	22.4	24.8	18.1	14.0	100.0
	When shopping I bring a recycle bag, and I do not use the shop’s plastic bags	277	280	148	81	65	851
Lack of information on energy saving	When shopping I bring a recycle bag, and I do not use the shop’s plastic bags	32.5	32.9	17.4	9.5	7.6	100.0
	I purchase energy-efficient home electronic appliances	75	309	341	93	33	851
	I purchase energy-efficient home electronic appliances	8.8	36.3	40.1	10.9	3.9	100.0
	Government information on global environmental issues is insufficient	104	292	403	35	17	851
Energy and Environmental consciousness	Government information on global environmental issues is insufficient	12.2	34.3	47.4	4.1	2.0	100.0
	Electricity and gas company information on global environmental problems is insufficient	83	261	463	29	15	851
	Electricity and gas company information on global environmental problems is insufficient	9.8	30.7	54.4	3.4	1.8	100.0
	There is a lack of information on types and prices of energy saving home appliances	74	294	413	55	15	851
Energy and Environmental consciousness	There is a lack of information on types and prices of energy saving home appliances	8.7	34.5	48.5	6.5	1.8	100.0
	It is difficult to understand the effect of energy saving home appliances and the amount of money saved	125	377	296	41	12	851
	It is difficult to understand the effect of energy saving home appliances and the amount of money saved	14.7	44.3	34.8	4.8	1.4	100.0
	It is hard to know what devices should be replaced with energy saving home appliances	92	344	329	68	18	851
Energy and Environmental consciousness	It is hard to know what devices should be replaced with energy saving home appliances	10.8	40.4	38.7	8.0	2.1	100.0
	I will not save energy unless people around me do so	9	44	314	301	183	851
	I will not save energy unless people around me do so	1.1	5.2	36.9	35.4	21.5	100.0
	It is hard to know the environmental improvement effect of energy saving actions	95	349	345	46	16	851
Energy and Environmental consciousness	It is hard to know the environmental improvement effect of energy saving actions	11.2	41.0	40.5	5.4	1.9	100.0
	Policies to promote voluntary energy saving by consumers is important	140	359	318	21	13	851
	Policies to promote voluntary energy saving by consumers is important	16.5	42.2	37.4	2.5	1.5	100.0

We converted the responses by assigning two points to the answer “it applies to me,” one point to “it applies to me in a considerable degree,” and zero points to any of the other answers. Figure 4 shows the result of the point conversion where the maximum possible score is 46 points if all 23 items were assigned two points each. The maximum observed number of points for respondents was 42, the minimum was zero, and the average was 10.95 points. Ten

to 19 points accounted for about 46% of the total, less than ten points for 44%, and about 90% of all samples were less than 20 points. Thirteen points was the mode value (58 samples).

Figure 4. Converted points of environmental interests



### 3.3 Recognition of environmental labels

We asked respondents the following questions using a four-point scale: “I know it very well (I can explain the contents to people),” “I am fairly familiar with it (I know roughly the content),” “I do not know the contents, but have seen it,” and “I see it for the first time.”

Environmental labels are classified into three categories: type I is a third party certification program that awards the use of environmental labels on products (ISO 14024), type II is self-declared environmental claims by business operators (ISO 14021), and type III displays environmental data (ISO 14025). A previous survey examined eleven labels that are types I or III and asked respondents how well they recognize them (I know it very well/I am fairly familiar with it/I do not know it well) (Table 8). In selecting environmental labels, we referred to the Green Market + (Plus) Study Group (2011).

Over 40% of respondents answered, “I am fairly familiar with it” for the “Eco Mark” and “Low Emission Vehicles.” This is similar to results from a previous study. The labels that had the highest share of “I have seen it” were “Green mark” and “Recycled paper use mark.” For the other environmental labels, the answer “I am seeing it for the first time” was the most common. In a previous study, “the unified energy-saving labels” was fairly known, but in this study, the majority of respondents answered, “I am seeing it for the first time” (Table 9).

Table 8. Types of environmental labels and recognition levels from previous study

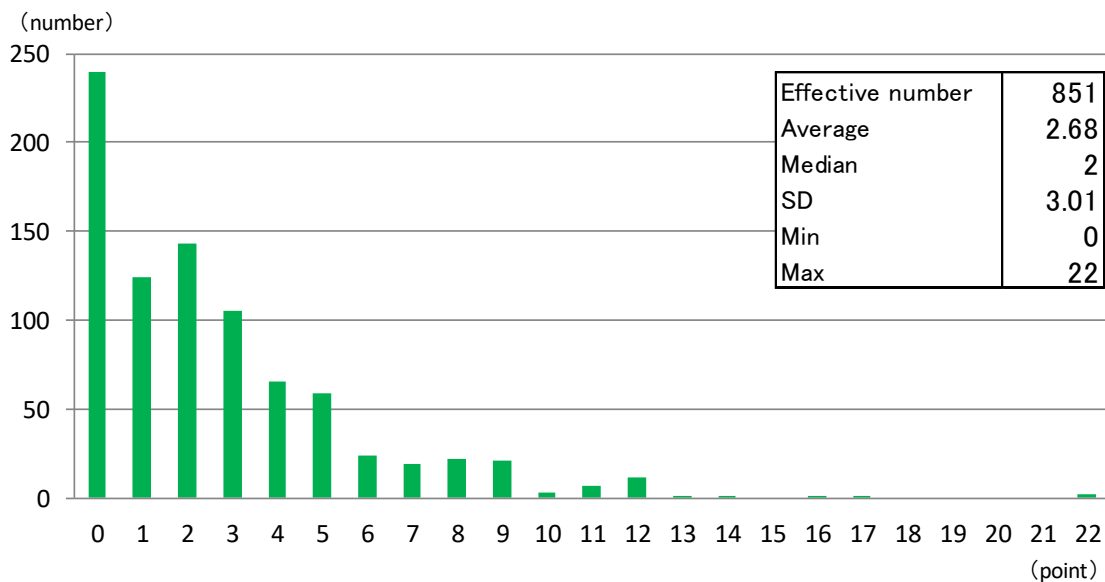
	Eco Labels	Recognition levels from previous study
Type I	Eco Mark	I know it very well
	Low emissions vehicle certification	I know it very well
	Unified energy saving labels	I am fairly familiar with it
	Eco rail mark	I do not know it well
	Eco First Company	I do not know it well
	Green mark	I am fairly familiar with it
	Mark of usage of recycled paper	no previous study
Type II	Ecoleaf	I do not know it well
	Carbon footprint	I do not know it well
	Declaration of environmental product	no previous study
	Carbon Offset Authentication	I do not know it well
	Carbon Neutral Authentication	

Table 9. Recognition of selected environmental labels

	I know them very well	I am fairly familiar with them	I do not know the contents, but have seen it	I do not know the contents, but have not seen it	Total %
Eco Mark	126 14.8	382 44.9	250 29.4	93 10.9	851 100.0
Low emissions vehicle certification	89 10.5	297 34.9	256 30.1	209 24.6	851 100.0
Unified energy saving labels	24 2.8	119 14.0	216 25.4	492 57.8	851 100.0
Eco rail mark	16 1.9	58 6.8	187 22.0	590 69.3	851 100.0
Eco First Company	5 0.6	36 4.2	151 17.7	659 77.4	851 100.0
Green mark	52 6.1	190 22.3	369 43.4	240 28.2	851 100.0
Mark of usage of recycled paper	94 11.0	237 27.8	304 35.7	216 25.4	851 100.0
Ecoleaf	5 0.6	36 4.2	146 17.2	664 78.0	851 100.0
Carbon footprint	5 0.6	34 4.0	66 7.8	746 87.7	851 100.0
Declaration of environmental product	4 0.5	15 1.8	68 8.0	764 89.8	851 100.0
Carbon Offset Authentication	3	31	101	716	851
Carbon Neutral Authentication	0.4	3.6	11.9	84.1	100.0

The four-point scale was converted to points in the following way: “I know it very well (I can explain the contents to people)” was assigned two points, “I am fairly familiar with it (I know roughly the content)” was assigned one point, and other choices were assigned zero points. Based on this, the responses were converted into points with a maximum of 22 points, which is when all eleven labels were assigned two points (Figure 5). The maximum number of points was 22, the minimum number of points was zero, and the average of all samples was 2.68 points. One to three points accounted for about 44% of the total, which was the largest segment, and then four to six points comprised about 18%. Ten points or more was only 3% of the total, and zero points accounted for about 28% of the total.

Figure 5. Converted points for recognition of environmental labels



#### 4. Results of the analysis

In this section, we summarize the results of the correlation analysis and principal component analysis.

##### 4.1 Correlation analysis results

Table 10 shows the results of the correlation analysis of environmental actions, level of

environmental interest and extent of recognition of environmental labels. There is a statistically significant correlation between environmental actions of energy reduction efforts and peak shift agreements, and environmental consciousness and extent of recognition of environmental labels. Although registration for the electric household account book shows a statistically significant correlation with recognition of environmental labels, correlation with environmental consciousness could not be established. This could be because the electric household account book is not well known, but on the other hand, since it is correlated with the extent of recognition of environmental labels, it may be the case that there is a common factor among people who recognize some labels.

Table 10. Correlation analysis of environmental actions and environmental consciousness

		Reduction efforts	The registration status of the electric household account book	The agreement on power peak shift	Environmental consciousness	Recognition of environmental levels
Reduction efforts	Pearson coefficient of correlation	1	.067	-.115**	.282**	.187**
	Significance probability(two sided)		.050	.001	.000	.000
The registration status of the electric household account book	Pearson coefficient of correlation	.067	1	-.208**	.050	.115**
	Significance probability(two sided)	.050		.000	.148	.001
The agreement on power peak shift	Pearson coefficient of correlation	-.115**	-.208**	1	-.177**	-.156**
	Significance probability(two sided)	.001	.000		.000	.000
Environmental consciousness	Pearson coefficient of correlation	.282**	.050	-.177**	1	.270**
	Significance probability(two sided)	.000	.148	.000		.000
Recognition of environmental levels	Pearson coefficient of correlation	.187**	.115**	-.156**	.270**	1
	Significance probability(two sided)	.000	.001	.000	.000	

## 4.2 Principal Component Analysis Result

The data is classified into five components as a result of principal component analysis. This is done by using attribute data and the extent to which environmental labels are recognized together with environmental actions and level of environmental interest (Table 11).

The first principal component is internal/external factors because family or personal factors and social factors appear to be at opposite poles. The second principal component is the energy use factor because the size of the residence and time spent at home, which are factors that increase energy use, and reduction efforts to suppress energy use, etc. appear in opposite poles. Although it may not be as obvious as the other principal components, the third principal component is the control consciousness factor, because there are things that people are aware of and can control, while there are other things that people are aware



of but cannot control.

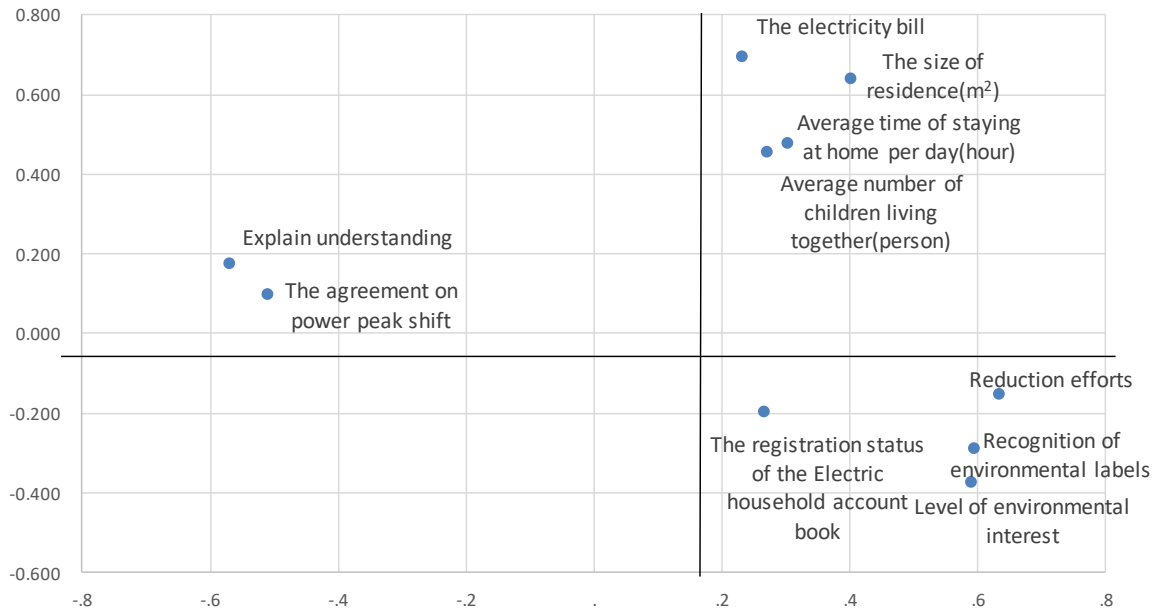
Table 11. Results of the principal component analysis

	Factor		
	Internal/external factor	The energy use factor	The control consciousness factor
The registration status of the Electric household account book	0.264	-0.192	-0.488
The electricity bill	0.23	0.696	-0.064
Level of environmental interest	0.59	-0.37	0.32
Reduction efforts	0.632	-0.15	0.41
Recognition of environmental labels	0.593	-0.285	-0.98
Explain understanding	-0.572	0.177	0.127
The size of residence(m <sup>2</sup> )	0.4	0.643	0.032
Average time of staying at home per day(hour)	0.302	0.48	0.449
The agreement on power peak shift	-0.511	0.101	0.406
Average number of children living together(person)	0.269	0.46	-0.427

Figure 6 is a scatter diagram of the first and second principal components. From the distances between mutual variables, we see that environmental consciousness and the extent to which environmental labels are recognized are linked with environmental actions of energy reduction efforts, and the electric household account book. On the other hand, the size of residence, time spent at home, and number of children living together are factors that increase the use of energy, but interestingly, variables such as environmental consciousness are in the opposite positions of these factors.

This shows that the degree of comprehension of information on the environment promotes comprehension of environmental efforts in society as a whole, such as peak shifting. This implies that an easy-to-understand way of providing information may be effective in reducing energy use, but further research and discussion is required to determine this.

Figure 6. Principal component analysis results



## 5. Conclusion

In this study, we examined how environmental actions are related to environmental consciousness, and the extent to which environmental labels are recognized. Supporting the initial hypothesis, we found that environmental actions are influenced by environmental consciousness, and differences in the extent to which environmental labels are recognized. Specifically, people who have high environmental consciousness, and people who know more about environmental labels tend to be supportive of peak shifting. At the same time, people with a high level of understanding about how the peak shift is explained tend to be supportive. From this, we infer that apart from the level of environmental consciousness, the way in which information is provided is also important.

In the correlation analysis of environmental consciousness and the extent to which environmental labels are recognized, we confirmed correlation between the both. However, regarding the electric household account book, it is not a simple correlation since it is correlated only with the degree to which environmental labels are recognized. Therefore, further investigation is necessary on this point.

In Japan, where efforts for CO<sub>2</sub> reduction continue, environmental actions of consumers are becoming increasingly important. A significant contribution of this study was exploring the possibility of inducing environmental actions not only for consumers with high environmental consciousness, but also to others by using effective ways of explaining new concepts, etc. In the future, we intend to examine the relationship between environmental actions, the mechanism of providing information, and how this information is understood.

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