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# Determinants and policy implications for household electricity-saving behaviour: Evidence from Beijing, China

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#### Abstract:

This research sets out to explore the possibilities for further saving in household electricity consumption through a study of the residents' willingness and behavioural characteristics in electricity saving, as applied within a Chinese context. Based on an extensive literature review, the authors argue that economic benefits, policy and social norms, and past experience may have a positive correlation with household electricity-saving behaviour, while the discomfort caused by electricity-saving activities, may exert a negative effect on it. Through a sample of 816 randomly selected residents in Beijing, the propositions are examined using logit regression analysis. The conclusions support the ideas, concerning both the positive influence of economic benefits, policy and social norms, and past experience as they affect broader electricity-saving behaviour, and the negative influence of the discomfort caused by electricity-saving activities. Finally, some inferences are drawn, and suggestions are offered for policy makers and further studies.

Keywords: Electricity-saving; Household behavior; Policy Implication.

#### 1. Introduction

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As the second largest energy producer and consumer in the world, China has attached great importance to energy conservation. As a coal-based economy, China enjoys huge potential in its domestic energy supply. However, with its rapid economic growth, the disparity between the energy consumption and production are becoming increasingly greater in recent years. For example, in 2007 the total energy consumption in China was about 2.66 billion tons standard coal equivalent (SCE), while the energy production was only about 2.35 billon tons SCE (NBSC, 2009). Such glaring disparity is especially salient in electricity consumption and supply. Taking Beijing as an example, the total consumption of electricity in 2007 was about 67.5 billion kWh. However, only 22.4 billion kWh was generated in Beijing, with more than 65% of electricity imported from neighboring provinces (BBSC, 2009). It is therefore urgent for China to improve the efficiency of energy use and encourage energy conservation.

Households have been identified by researchers as an important target group for energy conservation. To illustrate, households account for 25% of the total energy consumption in the US, 26% in Japan, and 50% in Saudi Arabia (Saidur, et al., 2007). Given this, reducing the waste or inefficiency of household energy use can be an effective means of decreasing global energy requirements and related adverse environmental impacts. As Murata et al. (2008) argue, '28% reduction in China could be achieved by the year 2020 by means of improving citizens' energy efficiency in household appliances use'. Again, to take Beijing as an example, household electricity consumption accounts for 15.8% of the total consumption in 2007, which is equivalent to 10.7 billion kWh. There is a great potential to relieve the pressure of electricity shortage by further encouraging residents' electricity-saving behaviour. Since households can make a great contribution to energy conservation, in order to effectively encourage household energy-saving behaviour, it is necessary to identify what are the key

behavioural antecedents.

Literature suggests that different types of energy-saving behaviour are related to different behavioural antecedents (e.g. Stern and Oskamp, 1987; McKenzie-Mohr et al., 1995; Hansla et al., 2008). As to household energy-saving behaviour, scholars have indicated various determinants including psychological factors (Becker, et al., 1981), and socio-demographic issues (Gatersleben, et al., 2002; Moll, et al., 2005). Although these antecedents have received varying levels of attention in the literatures, few, if any, researches of household electricity saving behaviour have addressed them in an integrated way.

In addition, most previous studies set out to explore the possibility to improve efficiency of energy use in Western world. A paucity of studies has addressed household electricity-saving behaviour in a Chinese context (Min et al., 1997; Price and Sinton, 2002; Lu, 2006; Andrews-Speed, 2009). As explaining human behaviour in all its complexity is a difficult task, the adaptability of Western management theory to non-Western cultural contexts is often questioned (Bryman and Bell, 2007). To address energy challenges in China in a timely manner, it is necessary to conduct a research to identify the key determinants of energy conservation behaviour, with China' unique political and cultural background taken into account, for example, the impact of policy and statutes issued by Chinese governments.

Given that lack of an comprehensive study on antecedents of electricity-saving behaviour and that almost no study has been executed to explore this topic in the Chinese context, the current paper attempts to address three issues: (1) what is the present situation of household electricity conservation in Beijing? (2) What are the major determinants that influence the household electricity saving behaviour in China? (3) Does policy direction exert any impact in encouraging household electricity saving behaviour? The remainder of this paper includes four sections. In the theoretical background section, the literature that related to electricity-saving behaviour and its associated determinants is reviewed to form the foundation for the study. Grounded in this review, the conceptual framework is formulated and hypotheses are posited. Following this, the research methodology section focuses on the description of sampling, data collection, and constructs. Research results arisen from factor analysis, reliability analysis and logistic regression analysis are then presented. Finally, a discussion on practical implications and directions for further research are provided

#### 2. Theoretical background

Most electricity conservation studies have focused on analyzing residents' willingness to increase their efforts to save electricity. Their electricity-saving behaviour is usually measured by examining the usage of energy-saving appliances (e.g. Lu, 2006; Saidur *et al.*, 2007; Widen *et al.*, 2009) or consumption of electricity generated by renewable energy (e.g., Longo and Markandya, 2008; Zografakis et al, 2010). Some studies also put target on energy-saving measures for assessment of household electricity-saving behaviour (e.g., Banfi and Farsi, 2008). Given that China is one of the largest consumer markets of electricity appliances, this paper is dedicated to exploring electricity-saving behaviour in household appliance usage. With reference to previous literature, a literature review on the antecedents of household appliance usage was conducted in the current study. Determinants influencing electricity-saving behaviour are summarized below to capture the homogenous nature of the most studies in this domain.

#### 2. 1 Antecedents of electricity-saving behaviour

The energy-saving behaviour may largely depend on psychological variables and

socio-demographic variables (Abrahamse and Steg, 2009). The theory of planned behaviour (TPB) (Ajzen, 1991) is often used to examine pro-environmental behaviour from the perspective of psychology (Bonnes and Bonaiuto, 2002). The use of energy-saving light bulbs (Meijnders et al., 2001), the use of unbleached paper (Harland and Staats, 1999), car use (Bamberg and Schmidt, 2003), and bus use for commuting (Heath and Gifford, 2002) seem to be effectively explained by variables from TPB. As shown in Figure 1, attitude, perceived behavioural control, subjective norm and residue effect can influence people's intention towards electricity saving behaviour.





Note: Ajzen, I., 1991. 'The theory of planned behaviour'. Organizational Behaviour and Human Decision Processes vol. 50, p182

As shown in Fig. 1, the TPB postulates four conceptually independent antecedents of intention. The first is the attitude, which can be measured by the degree to which an individual has a favourable or unfavourable evaluation of the particular behaviour. In current study, attitude refers to the degree of people's awareness of performing electricity-saving behaviour, which largely depends on the evaluation of preference to electricity saving and the information the individual holds towards such a behaviour. Pro-environment awareness plays a significant role in energy use and conservation (Samuelson, 1990). As Kristina and Patrik

(2010) conformed, residents' attitude towards environment is an important factor to predict their electricity saving activities. This perspective has been further supported by Zografakis et al. (2010) research; they argue that people with more energy saving information and stronger awareness for climate change are more likely to purchase renewable energy and participate energy-saving activities (Zografakis et al., 2010).

The second antecedent is the degree of perceived behavioural control, which refers to ease or difficulty of performing particular behaviour. It largely depends on the weighing of the costs and benefits in the process of performing specific behaviour, such as financial cost, effort, and time (Lindenberg and Steg, 2007). Feng and Sovacool (2010) conducted a research related to the relationship between electricity prices and the levels of consumption in China; the results indicate that the economical benefit have a great influence to electricity saving behaviour. This conclusion has been confirmed by several researches related to the effect of financial cost on household energy consumption (Banfi and Farsi, 2008; Scarpa and Willis, 2010). Besides, the comfort or discomfort (e.g. thermal comfort, air quality and noise protection) that residents fell when conducting certain kinds of electricity-saving behaviour have a significant influence on their further energy saving activities (Banfi and Farsi, 2008).

Subjective norm refers to the perceived social pressure to perform or refrain from behaviour (Abrahamse and Steg, 2009). From this point of view, the individuals' perception of external environment affects their behaviour a lot. Kristina and Soderholm (2010) have investigated that social interactions attach great importance to electricity saving behaviour. Other people's attitudes and behaviour in electricity saving may influence individuals' willingness for electricity saving activities. Besides, media promotion for environment protection and climate change may reduce residents' unnecessary electricity consumption. Furthermore, residual effect refers to the past behaviour or experience of individuals, which may affect their intention to perform particular behaviour (Ajzen, 1991). According to Zografaki et al. (2010), those who have invested in some energy saving measures, or the residents who had suffered electricity shortage before would intend to conduct more energy saving. Feng and Sovacool (2010) also indicated that the residents who had the experience of brownouts of electricity use in China would have more concern about electricity saving.

Beyond the framework of TPB, demographic variables are also attracted special attention of scholars in studying energy-saving behaviour. Evidences in the literature indicate that income level is a determinant of energy-saving behaviour, as people with lower income level are more likely to participate in energy saving activities (Al-Ghandoor, Jaber et al. 2009). Some studies noted that housing area is also a vital determinant of energy saving behaviour (e.g., Zografakis et al., 2010).

### 2.3 Hypothesis framework

By summarizing all the point made above, one can see that household electricity-saving behaviour can be predicted by a number of determinants, which mainly consist of psychological and socio-demographic factors. As culture attaches great importance to predict people's behaviour, residents' electricity saving behaviour in different countries may present more or less different characteristics. Since policy instruments and social propaganda are more frequently implemented to regulate the economy by Chinese government compared with many Western counties, they may play a significant role in influencing residents' daily lives, including their electricity-saving behavious. Nevertheless, pro-environmental awareness seems to have limited effect to predict Chinese residents' electricity-saving behaviour. Compared with Western residents, Chinese residents put more attention to the economic benefits or convenience. Besides, social interaction, as another predictor of household electricity-saving behaviour also requires further discussion, since candid communication among Chinese residents is rare (Zeng, 2005).

Considering these differences, a hypothesis framework combined with the determinants that previous studies have explored is displayed below (see Figure 2). We suppose that economic benefits, policy and social norms, past experience may have a positive influence on household electricity saving, while the discomfort caused by electricity-saving activities, may have a negative effect. Nevertheless, the effects of environmental awareness and social interactions about electricity saving experience on household electricity-saving may be not obvious in Beijing and need to be further confirmed. In addition, some socio-demographic variables are also taken into account to predict household electricity-saving behaviour.



Hypothesis framework

#### 3. Methodology

### 3.1 Sample and data collection

Re-stated, the present study aims to identify the determinants of household

electricity-saving behaviour in Beijing. A questionnaire was duly devised, and using a random sampling method, a sample of 1500 residents living in residential quarter of Beijing's urban area was selected. Some neighborhood committees, which are the community management organizations of residential quarter in China, were enlisted to help distribute questionnaires to the residents on the spot. The following are explanations for our survey style:

- Unlike their foreign counterparts, Chinese urban residents mainly live in a compact community called residential quarter. Taking residents living in these residential quarters as our research subjects would not only be convenient for data collection, but also by this practice the sample reasonably represent research population— Beijing household.
- Usually, the response rate of postal survey in China is relatively low. Filling in questionnaires is time-consuming; it is also inconvenient for the respondents to mail them back. As a result, most respondents show little interest.
- The neighborhood committees are often very familiar with residents living in their residential quarters. Enlisting their help can improve the credibility and raise response rate of the survey.

The design of the questionnaire was based on the hypotheses framework as shown in Figure 2, with the content divided into three main sections: Awareness of household electricity saving, factors related to household electricity use and saving behaviour, and basic individual information. The construct to measure behaviourial determinants consists of 16 items. For each item, a five-point Likert scale was used to enable respondents to indicate the extent to which they agree with these items(1= not at all important, 2= not important, 3= not thinking about it, 4= important, 5= extremely important). And the question to evaluate household

willingness in electricity saving is "Do you often take some actions on household electricity saving (e.g. pull off the plug after using electricity appliances or choose to buy energy efficient household appliances)?" To answer this question, respondents were asked to tick one of two boxes: 1-YES; 0-NO.

Probably because the researchers enlisted the help of neighborhood committees, the response rate was quite high (62.26%), which could be considered satisfactory for such a comprehensive survey. 118 out of 943 returned questionnaires were deleted, having failed to answer more than 40% of the total questions. Finally, a total of 816 usable responses were received. 311 responses in these 816 questionnaires were followed up with phone calls to collect answers for unfilled questions in first wave.

To assess the potential non-response bias, the differences in the mean values of the determinants between the 311 responses and the rest 505 responses were checked. The results showed no significant differences between usable respondents and the others at 0.05 level. This indicates that non-response bias is not a major problem in our study and the results from the sampled residents could be generalizable to others in Beijing.

### 3.2 Modeling household willingness to participate in electricity saving

An econometric model was developed to identify the antecedents of household electricity-saving behaviour in Beijing. When the dependent variable is in 0-1 style, researchers have a choice between logistic regression and probit regression. According to Borsch-Supan (1990), the logistic model is the better choice if the response decision is made based on maximization of utility. Given that residents' willingness in electricity-saving mainly depends on the expected utility from their saving behaviour, the logistic model was selected in current research. The following specification was used:

$$\text{Logit} (\mathbf{R}) = \frac{1}{1 + e^{-z}} \qquad z = \beta_0 + \sum_{i=1}^n \beta_i x_i + \varepsilon_i$$
(1)

- Where z: Latent and continuous measure of residents' willingness in electricity saving.
  - $x_i$ : The vector of observations of explanatory variables.
  - $\beta$ : The vector of parameters to be estimated.
  - $\varepsilon$ : The random error term (assumed to follow a standard normal distribution).
  - R: The observed and coded discrete willingness variable.

Table.1 presents the descriptive statistics for both dependent and independent variables used in the econometric model. To form a single indicator factor, each independent variable is measured by the mean of their evaluating items. This can reduce the model complexity and allow more accurate assessment for the determinants of electricity-saving behaviour. Some demographic variables (e.g. age, dwelling area, education) are also introduced in our regression model as control variables. This is to account for the possibility that the distinctions of the respondents may influence the extent of their electricity conservation behaviour, which has also been discussed in our hypothesis framework.

Table 1

Variables included in the analysis: descriptive statistics							
Items	Ν	Mean	S.D.				
<b>Dependent variables</b> Household willingness in electricity saving	816	0.61	0.489				
Independent variables							
Economic benefits		2.68	0.200				
Less expenditure from electricity saving	816	2.73	0.729				
Subsidy for energy conservation appliance use	814	2.64	0.824				
Policy and social propaganda		2.59	0.658				
Government support	815	2.20	0.766				

Social norms	815	2.21	0.998
Media Propaganda for electricity saving	815	3.34	1.203
Past experience		2.17	0.122
Experience for electricity shortfall	816	2.25	0.938
Habits of electricity saving in daily lives	816	2.08	1.022
Perceived inconvenience		2.04	0.202
Discomfort from electricity saving	816	2.18	0.781
Perceived time-wasted from electricity saving	816	1.90	0.833
Social interaction		2.84	0.205
Influence from friends' electricity saving behaviour	816	2.70	0.806
Community activities of electricity saving	816	2.99	0.971
Environment awareness		2.75	0.245
Awareness of energy crisis	813	2.81	0.886
Realization of global climate change	813	2.79	0.922
Awareness of environmental protection	813	2.66	0.815
Information		2.48	0.138
Knowledge of methods for electricity saving	814	2.48	0.851
Comprehension of energy efficiency labels	814	2.62	1.28
Realization of policy or regulation in energy saving	814	2.34	0.797

#### 4. Results

#### 4.1 Sample description

According to our questionnaire survey, there is a relatively high awareness among Beijing residents about the environmental burden and resource scarcity. About 65.32% of respondents have clearly noticed the negative environmental effects due to energy intensive consumption, especially the climate change; nearly half of respondents paid special attention to the national policies and regulations regarding energy conservation. However, such awareness does not translate in to electricity saving behaviour. The results indicate that a large amount of residents in Beijing paid little attention to electricity use in their daily lives. About 69% of

respondents said that "I do not know my last month electricity bill," and 45% of respondents even do not know current electricity price. Besides, the popularization of electricity saving appliances in China still lags behind that in more developed countries. Only 39.46% of respondents indicated that they have selected the electricity saving appliances as their main options for home appliances.

The estimates from the questionnaire survey also show that the perceived inconvenience for participating in electricity saving activities, together with the high cost of electricity saving appliances, might slump residents' willingness for electricity saving. According to the research results, inconvenience in purchase and usage<sup>1</sup> (accounting for 27.59%) is second to high price (28.16%) as the main reason for respondents' reluctance to use them. And 22.41% of respondents feel uncertain about the durability of electricity efficiency appliances and point to the inconvenience that might come with such appliances.

Moreover, we specially estimated the impact of economic factors on household electricity-saving behaviour. In our questionnaire, respondents were asked to answer the question "which one would you like to buy: an electricity saving appliance that requires an extra payment, or an appliance that is the same with the above mentioned one in all aspects expect that it is not electricity-saving and does not exact the extra payment?" 20.27% of respondents said they were unwilling to choose the electricity-saving appliances. And most respondents (about 57.37%) expressed that the extra payment they deem acceptable would be under 10% of original price. Only 4.67% of respondents would like to pay more than 20%. Then, we made a further crosstab analysis to find out whether it is related to household income level and self-perception of individual electricity consumption level. Figure 3 shows

<sup>&</sup>lt;sup>1</sup> For exzample, some respondents expressed that it is often wasted some time to clarify the levels of energy-efficiency when buying the appliances. And some respondents thought there are often more buttons and complicated design on many energy-efficient appliances comparing with inefficient ones. It is troublesome to hold corresponding operation skills.

that there are no significant differences among the respondents of different income levels in their acceptance to pay extra for an electricity saving appliance (Pearson Chi-square=10.690, Sig. =0.556). However, the respondents who have recognized themselves as excessive consumer of electricity seem more willing to switch to electricity-saving appliances (Pearson Chi-square=23.238, Sig. =0.026), as shown in Figure 4. It is indicated that economic benefits for encouraging electricity saving should be combined with an effort to strengthen residents' awareness of their excessive electricity use.



Fig.3. Crosstab between household willingness to pay extra money for electricity saving appliances and income level



**Fig.4**. Crosstab between household willingness to pay extra money for electricity saving appliances and self-perception of individual electricity consumption level

#### 4.2 The logistic regression analysis

Table 2 presents the results of logistic regression analysis. To assess the overall fitness of the model, Hosemer and Lemeshow goodness-of -fit test was examined, since it is usually considered as a critical statistic to detect incorrect model specification such as non-linearity in the predictors or missing predictors. The output corresponding to the Hosmer-Lemeshow statistic together with Likelihood ratio values (See Table 2 below) indicate that it is reasonable to reject the null hypotheses that the independent variables are not associated with the dependent variable. Cox & Snell R Square and Nagelkerke R Square are 0.147 and 0.2 respectively. The empirical results in terms of estimated coefficients and corresponding Wald-test values are displayed in Table 2. Wald statistic in the outcome shows that the coefficients are significantly different from zero, then we can assume that the predictors are making a significant contribution to the prediction of the outcome. Multi-collinearity was further checked among independent variables. Variance inflation factor (VIF) for all independent variables range from 1.024 to 1.401, which all well below the maximum level of 10.0 suggested by Mason and Perreault (Mason and Perreault, 1991). This means multi-collinearity should not be a serious concern in our regression. These results support the sound explanatory power and validity of integral estimate.

#### Table 2

Parameter estimates for the logistic regression model							
Indep. Variables	B <sup>a</sup>	S.E.	Wald	df	Sig.	Exp(B)	VIF

Economic benefits	.758	.140	29.169	1	.000	2.134	1.192
Policy and social norms	.301	.147	4.226	1	.040	1.352	1.319
Past experience	.221	.125	3.133	1	.077	1.247	1.284
Perceived inconvenience	363	.127	8.209	1	.004	.696	1.081
Social interaction	098	.135	.531	1	.466	.906	1.357
Dwelling area	177	.080	4.851	1	.028	.838	1.024
Age	.386	.074	27.142	1	.000	1.471	1.054
Information	.304	.136	5.027	1	.025	1.356	1.251
Environmental awareness	.189	.141	1.794	1	.180	1.208	1.401
Constant	-3.793	.616	37.864	1	.000	.023	
-2Log-liklihood	951.139				.000		
Hosmer and Lemeshow	6.791				.559		

<sup>a</sup> Estimation terminated at iteration number 4 because parameter estimates changed by less than .001

In general, the variables have statistically significant impacts on the stated willingness to save more electricity seem to be more or less the same as the framework built at the 2.2 section. It indicates that economic benefits, policy and social norms, perceived inconvenience and information, are statistically significant at the 5% significant level, and past experience is significant at 10% level. However, environmental awareness and social interaction were not verified in our model. Individual differences in socio-economic background (such as level of education, income and gender) were initially included in the logistic regression estimations, but most of them had no significant impact on the willingness to reduce electricity consumption. The only exceptions were age and dwelling area, both of which were estimated both significant at 5% level.

The results of regression analysis demonstrated that economic benefit is one of the main antecedents of residents' electricity-saving behaviour in Beijing. With the great improvement of living standard for Beijing residents, various appliances flow into the families and the electricity consumption accounts larger share in residents' daily consumption. Electricity saving has become one of the main channels decrease household daily expenses. And according to our survey, 80.2% of respondents would not accept the increasing electricity price, and respondents that recognized the financial pressure from electricity costs were also more reluctant to undertake further measures to save electricity.

Our results also support the hypothesis that polices and social norms play a significant role in promoting electricity saving behaviour of residents in Beijing. Chinese government has attached great importance to the electricity saving, and implemented many measures to promote residents' energy-saving behaviour. For example, some subsidies for energy saving appliances purchasing was put into effect to incite electricity saving. And about 57.5% of respondents said that they would choose electricity-saving products, someone condition of being subsidized by the government.

Moreover, people holding more information on electricity-saving and better knowledge of policies regarding electricity use are more willing to participate in electricity saving than those without. This is because this specific knowledge presupposes a high awareness of methods for efficient electricity-saving. Adequate information normally results from frequent promotion of energy saving and environment protection by media.

Furthermore, residual effect was verified as a positive influence on residents' electricity-saving behaviour. Respondents with past experience of energy saving practices or electricity shortage are more willing to participate in electricity-saving activities. Because of the combination of rapidly rising industrial demand for electricity and high household power consumption, shortfalls in electricity supply are often announced in Beijing. Many respondents have experienced the curtailed electricity use through rolling brownouts initiated by government. As expected, electricity shortage has a positive correlation with residents' willingness for electricity saving. More frequent electricity shortage might raise residents' consciousness of electricity saving. This is consistent with our priori expectations and

previous research studies (Longo and Markandya, 2008; Carisson and Martinsson, 2008).

Inconvenience and discomfort caused by electricity saving has a significantly negative effect on respondents' willingness for reducing unnecessary electricity use. This observation points to the limitation of electricity-saving infrastructure and poor technologies for electricity efficiency projects in Beijing. It is worth mentioning that all these disadvantages have erected visible obstacles to residents' daily electricity saving activities. According to our research, the stronger discomfort the respondents feel when they take part in electricity saving, the less willing they are to save electricity.

Contrary to many previous research studies (e.g., Sardianou, 2007; Linden and Carlsson-Kanyama, 2006; Viklund, 2004), the logistic regression results provide limited support for the environment awareness. As is supposed in section 2.2, environment awareness might not easily translate into direct pro-environment behaviour. There is still a big gap in China between electricity saving awareness and real action. Also, social interactions and knowledge of others' behaviour in electricity saving were not significant in Beijing. One possible explanation might be that it is difficult to identify other people's electricity behaviour, and the accelerating pace of life reduces the opportunities for residents to communicate with each other.

For the demographic variables, seniority in age exerts a positive effect on electricity saving while spaciousness of a dwelling works as a negative influence. The old respondents, especially the retired people, report a high willingness for reducing unnecessary electricity use, while respondents living in larger dwellings are less willing to take part in electricity saving. One plausible explanation for the former result is that old people experience more electricity shortfalls, especially in 1970s, a time when conservative energy behaviour was fostered in China. And this induced constant saving habits among Chinese households. For the latter result, the cause is that respondents who live in large dwellings are well-off. The opportunity cost of spending time in electricity-saving activities is perceived high by those residents, because time for them is a more scarce resource, better to be spent enjoying a convenience life.

#### 5. Discussion and policy implications

The results hereby presented demonstrate that household electricity saving behaviour lacks sufficient encouragement in Beijing, because the policy to address this issue is by far limited to financial incentives, infrastructure construction and public acceptance. And it is known that the design and implementation of any electricity saving policy should first identify the impetus for and barriers to household electricity conservation. It follows that further policy measures have to be conducted with the determinants examined above taken into account.

Firstly, more educational campaigns and social propagandizing for energy crisis and household electricity-saving skills should be initiated with more government support. Meanwhile, excessive administrative interventions in electricity market need to be phased out. This study points to a lack of consciousness of the energy exhaustion among Beijing residents. Most residents perceive little burden imposed in their daily lives by the electricity shortage, a problem largely due to policies that ensure Beijing's precedence over other regions in energy use. As we know, the neighboring provinces (e.g. Hebei, Inner Mongolia and Shanxi province) provide more than 65% of electricity supply for Beijing. It is sometimes the case that administrative directives by Chinese central government even require these provinces to meet the electricity demand of Beijing at the expense of their own electricity needs, especially during important activities (e.g. 2008 Beijing Olympic Games) or during the period of power consumption peak (e.g. Spring Festival). Fewer residents in Beijing, especially the young people, have ever experienced the electricity brownouts, which points to the necessity to strengthen residents' consciousness of electricity shortfall in an effort to improve household electricity efficiency. At the same time, more market measures should replace present mandatory directives in order to balance the demand and supply of electricity in Beijing. The price variation following the change in electricity demand and supply under market mechanism can intensify residents' awareness of electricity scarcity and motivate their electricity-saving behaviour.

Moreover, policies applied for enhancement of residents' electricity-saving awareness should be combined with cost saving and utility improvement approaches. Many researches increasingly highlight the residents' environment awareness as a key factor to promote electricity-saving behaviour, without an emphasis on how to transform such awareness into actual conservation behaviour. As shown in current study, however, the role of environment awareness in electricity saving is by far limited. There may be strong consciousness of energy scarcity and environmental degradation in Beijing households. However, it is also witnessed that there exists a significant inertia among Beijing residents in their electricity saving behavior. This finding represents a challenge to translate the environment awareness into electricity saving action. An important reason for this is that technologically feasible "cost-effective" approaches for reducing electricity use and other notable barriers such as management, retraining time and capital constraints are overlooked when environment awareness is promoted to increase. Inconveniences and discomfort arising from electricity saving were not effectively mitigated. This impedes the residents from transforming their environment awareness into electricity-saving actions. Therefore, it is necessary to further encourage the improvement of electricity saving technology with more policy support, and replace the backward household electricity infrastructure with more energy-efficient ones.

Furthermore, policy makers should pay more attention to the increasing electricity consumption of residents living in big dwellings. As shown in this research, a small dwelling area could be beneficial for household electricity saving. However, the dwelling area of new constructed dwellings in Beijing shows little indication to be smaller. Even the newly completed economically affordable dwellings (EAH), which provide housing for low-income residents in Beijing, reached 101.44 square meters each on average in 2008 (BBSC, 2009). Given this reality, it is necessary to push forward tiered pricing for household electricity in Beijing. 2 or 3 hierarchies with incremental unit price for electricity in each hierarchy could be drawn up, excluding the basic household demand. Extra charge would be levied if the amount of electricity consumption exceeds the standard for each hierarchy. Residents, who pay more marginal cost of electricity due to their large dwellings, in turn have to pay more attention to their daily electricity consumption.

Above all, policy tools with respect to household electricity saving would not only focus on residents' environmental awareness, but also should incorporate financial benefits (e.g. financial subsidies and tax preference) and technological upgrading (e.g. to make the usage of electricity-efficient products more convenient). It is argued that there exists a relatively high awareness among some residents about the benefits associated with electricity conservation, but few behavioural-related actions are implemented. Such situation demonstrates that more attention should be paid to encouraging the household to undertake saving measures. Widespread of information on electricity-saving knowledge should also be part of effective policy to stimulate vigorous reductions household electricity consumption.

### 6. Conclusions

This paper focuses on the relationship between willingness and behaviour of Beijing residents in electricity-saving The topic selection is motivated in part by the fact that past policy tools towards energy conservation and emission reduction in China tended to focus more on adjustment of industrial structure but less on behaviour-related measures (Gyberg and Palm, 2009). The results indicate that there is a great potential to reduce unnecessary electricity use from the household perspective. The arguments particularly focus on the energy-efficient products utilization and household electricity consumption to estimate the willingness of households to undertake saving measures. It is illustrated that electricity-saving behaviour are not effectively encouraged in Beijing, which leaves enough space for further policy instruments implementation.

The determinants of Beijing residents' willingness to increase efforts on electricity saving have also been analyzed in this study. It is noted that economic benefits, comfort and convenience, information are important determinants to predict the household electricity-saving behaviour. Besides, past experience of electricity shortfall exerts a significant residual effect on household electricity-saving behaviour. Our study also illustrates that policy and social norms attach great importance to reduce daily unnecessary electricity use. And the implementation of effective electricity-saving policies and corresponding management system should depend largely on those determinants.

According to the research, however, environment awareness has no significant influence on residents' electricity-saving actions. Policies aiming to strengthen people's consciousness of energy scarcity and environmental degradation play a limited role in household electricity saving. Moreover, the differences in the level of social interaction found in the questionnaire had insignificant impact on the reported willingness for electricity saving. This is consistent with the fact that information share and communication of electricity-saving skills with other people is so far limited in Beijing.

The results presented above in this paper provide relevant knowledge on designing future informative policy measures in dwelling electricity saving. Both economic motives and technologically feasible approaches (conducted to, for instance, avoid the inconvenience caused by electricity saving) are very urgent for reduction of unnecessary electricity use in Beijing. And educational campaigns which tend to lay stronger emphasis on disseminating electricity saving measures to residents should be promoted and initiated by interest organizations, authorities, and residential communities. Furthermore, although there is a comparatively high environmental awareness among Beijing residents, an effective policy management system coordinating with dissemination of energy saving information and financial incentives needs to be constructed to render the pro-environment consciousness into electricity saving action.

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