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Factors influencing energy-saving behavior of urban households in Jiangsu Province



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HIGHLIGHTS

- A broad and practical conceptual framework of energy-saving behaviors is built.
- Socio-demographic characteristics are determinants of energy-saving behavior.
- Respondents adopt the usage-reduction type more often than the other two types.
- Situational factors have positive moderating effects on the other two variables.
- Spatial differences exist among the three regions of Jiangsu Province.

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ABSTRACT

In this research, the willingness of households to adopt different energy-saving behavior has been analyzed, and factors influencing energy-saving behavior in Jiangsu Province, China, have been examined. The study builds on a broad and practical conceptual framework that embraces three types of energy-saving behavior and four dimensions of influencing factors, including socio-demographics, energy-saving awareness, behavioral ability, and situational factors. The empirical results are based on an Internet survey that was sent out to 638 households. The results indicate that socio-demographic characteristics, including age, gender, income level, household structure, and educational background, are all important factors influencing energy-saving behavior. At present, respondents adopt the usage-reduction type of behavior more often than the other two types, which require a greater capacity to pay for energy-efficient products and a higher level of energy-saving awareness. Situational factors have significant positive moderating effects when the variables of behavioral ability and energy-saving awareness act on energy-saving behavior. In addition, the results also show that spatial differences exist among the three regions of Jiangsu Province. Finally, some implications of these results for the design of future incentive policies and measures to encourage energy-saving behavior are presented.

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1. Introduction

Global climate control has recently emerged as an important international issue. However, in China, economic growth and improvements in living standards are leading to higher household energy demand and consumption (Ouyang and Hokao, 2009; Wang et al., 2011, 2012a; Song et al., 2013; Yue et al., 2013). Promoting energy-efficient technology and new energy development is not sufficient to solve the problems of high energy consumption and environmental pollution. However, changing people's energy-consumption behavior can potentially make a great contribution towards solving the problem (Ouyang and Hokao,

2009; Abrahamse et al., 2007; Feng et al., 2010). Consequently, energy conservation by individuals has become a significant focus for the research worldwide.

Household energy usage in China accounted for about 10% of total energy consumption in 2010 (NBSC, 2012) and about 7% in Jiangsu Province in 2011 (BSJS, 2012). Although these percentages are not larger, comparing with those in developed countries, the lack of energy resources to meet the demand highlights the importance of household energy usage in China, especially in Jiangsu Province which has a high-carbon energy-consumption structure. Urban energy consumption across China accounted for approximately 60% of all usage; however, in Jiangsu Province, it accounted for about 82% (DES, 2011). Urban usage is a representative of end-user energy consumption in modern Chinese society to some extent; consequently, urban residents have a great potential to impact energy consumption.

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Divided regions in China have different economic development and energy efficiency (Wang et al., 2012b). Households also have widely differing patterns of energy consumption which are related to income levels, types of dwellings, household compositions, locations, and other factors (Druckman and Jackson, 2008; O'Doherty et al., 2008). The southern, central, and northern regions of Jiangsu Province exhibit clear regional differences in many aspects, including the physical geographic environment, levels of economic development, and cultural awareness. In 2011, the southern region produced a per capita GDP of 69,278 yuan, while the central region produced 39,263 yuan and the northern region produced 23,835 yuan (BSJS, 2012). Differences in households' energy-saving behavior might therefore exist in different regions.

Energy-saving behavior has generally been divided into two fundamental categories: habitual actions (e.g., direct curtailment and adjustment behavior, changes in usage habits) and purchasing activities (e.g., energy-efficient technology) (Black et al., 1985; Dillman et al., 1983; Stern, 1992; Van Raaij and Verhallen, 1983; Barr et al., 2005). Purchasing activities reduce energy usage by investing in technical equipment without changing the lifestyles (Cyberg and Palm, 2009). For example, consumers are willing to pay more for appliances with energy-efficiency labels (Shen and Saijo, 2009; Mills and Schleich, 2010; Gaspar and Antunes, 2011). Energy consumers can also be segmented into six groups: the idealistic, the selfless, the thrifty, the convenience-oriented, the indifferent, and the well-being-oriented energy consumer (Sütterlin et al., 2011).

Research on household energy use and energy-saving behavior has found that several types of factors can influence energy-usage behavior. For example, socio-demographics, moral norms, various incentives and barriers, energy-saving awareness and attitudes, regulations and policies, informational and promotional activities were considered as the important influencing factors (e.g., Olson, 1981; Winett et al., 1985; Steg, 2008; Stern, 1992; Kang et al., 2012; Black et al., 1985; DeWaters and Powers, 2011; Dias et al., 2004). Energy-saving behavior is strongly associated with the environmental attitudes, which are in turn associated with environmental beliefs, social norms, and community influence (Gadenne et al., 2011; Martinsson et al., 2011). Personal norms that affect willingness to change behavior are influenced by values and problems awareness (Nordlund and Garvill, 2003; Thøgersen and Grønhøj, 2010). Inability, unwillingness, and social obstacles are regarded as the primary barriers to changing household behavior patterns, according to psychological and behavioral studies of consumption and environmental awareness (Vringer et al., 2007).

However, according to Poortinga et al. (2003), the physical characteristics of energy-saving measures are as important as social and psychological factors in influencing household acceptability of energy-saving measures. The effects of information and various types of feedback on energy-saving behavior have spurred a large number of research studies to focus (e.g., Brandon and Lewis, 1999; Van Houwelingen and Van Raaij, 1989; Weenig et al., 1990). Policies designed to increase information availability may be as important in swaying household behavioral patterns as other policy measures such as taxes, subsidies, and infrastructure provision (EK and Söderholm, 2010). Research shows that providing households with information on their actual energy usage is one way to induce energy conservation without having to purchase more efficient appliances (Ueno et al., 2006a, 2006b).

Energy-consumption behavior and knowledge can be successfully affected by a combination of interventions, including tailored information, individual goal-setting, and personalized feedback to help people to think more holistically about the personal, social, and technological dimensions of energy conservation (Abrahamse et al., 2007; McCalley and Midden, 2002). Another study has found that interactive interviews integrated with energy-accounting

software can help the participants to achieve this kind of holistic thinking (Goldblatt et al., 2005). Similarly, an interactive and scalable Web-based tool can overcome the lack of personalization that characterizes many energy-saving campaigns (Benders et al., 2006). Almost all types of interventions used to change energy-usage behavior have varying degrees of success. For example, policies providing rewards for saving energy are effective over short time periods as long as feedback is given frequently (Abrahamse et al., 2005). The norm activation model can also significantly stimulate energy savings (Abrahamse and Steg, 2009; Allcott, 2011).

Studies have also found that group-level feedback and peer education can also lead individuals to modify their behavior even without economic reward (Carrico and Riemer, 2011). Environmental information on climate change and customized household energy-saving advices are not always effective without support from family and social networks, as well as supportive government policies (Bartiaux, 2008).

Although these dimensions of influencing factors have been identified in many research studies, the relationships between them have received little attention. As for the relationships between the factors, when formulating energy-saving systems to achieve sustainable development while maintaining consumers' quality of life, decision-makers, technical experts, stakeholders, and the public should deeply deliberate and communicate (Owens and Driffill, 2008; Sardonianou, 2007).

At present, China's energy-saving policy related to energy-usage reduction by residents focuses mainly on advanced energy-saving technology (e.g., provision of subsidies for purchase of energy-efficient appliances and alternative-fuel vehicles). However, this technical approach is widely considered to require large amounts of time and money, and in fact a change in habits can be fruitful without additional investment (Ouyang and Hokao, 2009). It also remains to be clarified, for households in the different regions of Jiangsu Province, whether these factors are influential, what are their patterns of adoption, and whether there are spatial differences among the three regions.

The purpose of this paper is to provide insights into the factors influencing energy-saving behavior, the mechanisms of action of these factors, the relationships among them, and the possible differences in behavior among the three regions of Jiangsu Province. In Section 2, a conceptual framework of behavioral theories and hypotheses are presented. Section 3 presents the survey design, experimental procedures, and sampling strategy. In Section 4, results of the empirical analysis are presented and discussed. Finally, in Section 5, conclusions are summarized and policy implications are discussed.

2. Conceptual framework and hypotheses

2.1. Conceptual framework

From the analysis described above, the factors influencing household energy-saving behavior can be summarized using four dimensions: socio-demographics, individual awareness, behavioral capacity, and external interventions (e.g., informational and educational campaigns, policy implementation, and subsidies). Most research studies on energy-saving behavior include surveys of target groups, generally using several known factors that have been proposed in the literatures. To obtain more practical survey results, before the survey was designed, a certain amount of useful information was extracted from a qualitative material by means of in-depth interviews based on a grounded theory. The in-depth interviews focused mainly on participants' opinions about energy issues, their attitudes towards energy

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