



# Who exhibits more energy-saving behavior in direct and indirect ways in china? The role of psychological factors and socio-demographics



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## HIGHLIGHTS

- A survey is used to explore Chinese urban residents' energy curtailment behaviors.
- Make a distinction between direct and indirect energy curtailment behaviors.
- Effects of demographic and psychological variables are different on two behaviors.
- Policy should target at specific behaviors and specific population.

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## ABSTRACT

This research explores the possibilities for further energy saving in households in the Chinese context by conducting of a survey on energy curtailment behaviors. We examine how people's demographic characteristics and psychological factors affect their direct and indirect energy curtailment behaviors at home, as well as the different effects of these antecedents. Results suggest that people with high sense of environmental responsibility and curtailment attitude are more likely to engage in both direct and indirect energy curtailment actions. Generally, indirect energy curtailment behavior is more strongly related to psychological and socio-demographic factors than direct behavior, and these socio-demographic factors vary for direct and indirect behaviors. Interesting patterns emerged with respect to gender, age, family structure, family income, and level of education. Results indicate that strengthening publicity and education to increase environmental awareness among Chinese urban residents would be effective in reducing household energy consumption, especially when the said measures target a specific population and specific behaviors.

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## 1. Introduction

Residential energy consumption typically accounts for approximately 10% of China's total energy use and related carbon emissions (Source: China Statistical Year Book). Along with the decrease of energy consumption per GDP of China's industrial sector (Wang and Yang, 2015), residential energy consumption is expected to continuously increase. This increase, which has been observed since 2001, indicates that households constitute an important target group for energy conservation and should be the focus of future attempts aimed at decreasing energy consumption and carbon emissions. As the researches that have been taken in

industrial sectors have greatly contributed to the design of policies to reduce the industrial energy consumption and carbon emissions in China (Zhang, 2003; Wang et al., 2012, 2015), the energy consumption in long overlooked residential sector also calls for attention from the scholar's point of view. In the west, household energy conservation has been an important research topic for decades because of energy shortage and the negative consequences of fossil energy use to the environment (Poortinga et al., 2003). Numerous studies have given insights into household energy use/conservation (Steg, 2008; Benders et al., 2006; Brandon and Lewis, 1999) and its relevant factors (Martinsson et al., 2011; Poortinga et al., 2003). Researchers also evaluated the effectiveness of interventions aiming to encourage households to reduce energy consumption (Abrahamse et al., 2005), indicating the importance of studying household energy saving potentials and approaches which could be used to better guide the design of policies.

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Different measures can be implemented to reduce household energy use. Although technical improvement and behavioral endeavor constitute two main aspects (Stern and Gardner, 1981; Poortinga et al., 2003), these aspects have different properties (Gardner and Stern, 1996). Bentzen (2004) and Wang et al. (2014) found that the rebound effect has weakened the development of energy-efficiency technology and has even led to higher energy usage in China's residential sector. This effect, in turn, highlights the importance of behavioral change in household energy use, which is presently gaining popularity.

For households, such energy-saving behaviors that are performed repeatedly and are associated with a change in everyday life as curtailment have been assumed to have important influence on total domestic energy consumption (Aarts and Dijksterhuis, 2000; Marechal, 2009). The prerequisite for the reduction of energy use among residents and the development of effective, targeted communication strategies and marketing instruments is the understanding of their energy curtailment behavior and the careful identification of the factors that influence their behavior.

Most previous studies focused more on direct energy saving at home as exemplified by turning off of the lights in time and rarely on people's indirect energy consumption that reflect their consumption choices. A number of studies proposed that home energy saving is performed both directly and indirectly (Abrahamse and Steg, 2009; Poortinga et al., 2003). Indirect energy use in the residential sector, which refers to energy consumption that is embedded in the goods and services consumed by residents, should also be considered. As indicated by Wang and Feng (2015), guiding consumption behavior toward a sustainable direction plays an effective role in controlling excessive industrial production because consumption behavior affects production as well as transportation behaviors. Moreover, the extent to which households save energy may depend on factors that act as barriers or opportunities for energy conservation, such as income, that may influence purchase decisions and the ability to pay energy bills. Similarly, the decision to reduce energy use is a conscious decision and entails conscious efforts to realize energy savings, indicating that relevant psychological factors would influence energy-saving behaviors.

Therefore, we investigate the behavioral levels of direct and indirect energy curtailment of Chinese urban residents and examine the effects of antecedents on their energy curtailment. Specifically, we aim to obtain the socio-demographic characteristics of Chinese urban residents who save more energy in their daily lives to highlight the most promising groups. Moreover, we aim to elaborate on tailored energy conservation strategies and policies that may encourage others who do not exhibit energy-saving behavior. Our study is distinct and important because it covers both direct and indirect aspects of curtailment behaviors and uses these aspects to fully understand such behaviors. Additionally, our study provides specific policy implications that target at different groups. In this manner, our research can help reduce energy consumption and the corresponding carbon emissions in the residential sector and address the huge energy pressure in China.

In the succeeding section, the concept of energy curtailment behavior and its direct and indirect aspects are introduced. A review of pertinent literature on psychological and socio-demographic variables related to curtailment behaviors is presented. Subsequently, the data and method used in this study are described. The main results of this study are presented, and the findings and their relevance to policies are discussed. Suggestions for future research are also put forward.

## 2. Literature review

### 2.1. Direct and indirect energy curtailment

Household energy curtailment behavior can be performed directly and indirectly. Direct energy use refers to daily domestic energy consumption using gas, electricity, and water, among others. Indirect energy use refers to energy consumption that is embedded in the goods and services consumed by residents. The availability of consumer goods and services has energy implications because of the use of fossil fuels in the production, transportation, and distribution processes. The choice and purchase of goods and services involves indirect energy consumption. Thus, indirect energy use should be considered part of domestic energy consumption. Local food production, for example, uses lesser amount of energy than those of other places, and simplified packaging products are more energy saving than complex packaging ones (Urban and Ščasný, 2012) based on the use of fossil fuels in the transportation and production processes. Accordingly, the direct energy curtailment behavior refers to the reduced use of gas, electricity, and water at home that are achieved through such measures as reducing the temperature setting for heat in unused rooms. Indirect energy use can be reduced by consuming less energy-intensive products, by shifting expenditures to goods with a lower energy intensity, or by shifting expenditures from

energy-intensive goods to energy-extensive services (Poortinga et al., 2003). Thus, indirect energy curtailment behavior refers to the behavior of buying goods and services, such as seasonal foods, that consume less energy and have less carbon implications during production and transportation (Sütterlina et al., 2011; Vringer and Blok, 1995).

Both direct and indirect energy saving occur nearly every day in our life. Approximately half of average household energy use is estimated to be indirect energy use (Reinders et al., 2003). However, compared with domestic direct energy curtailment behavior, indirect energy curtailment behavior has not been investigated in China. This gap should be addressed because further encouragement of both direct and indirect energy curtailment behaviors can potentially relieve the pressure of energy shortage and mitigate carbon emission increase.

### 2.2. Psychological and socio-demographic antecedents

Key antecedents for energy curtailment behaviors should be identified. Studies showed that different types of environmentally relevant behavior are related to different behavioral antecedents (e.g., Axelrod and Lehman, 1993; McKenzie-Mohr et al., 1995; Stern and Oskamp, 1987). Energy curtailment behavior is influenced by both psychological (Becker et al., 1981; Kaiser et al., 1999, Kaiser and Shimoda, 1999) and demographic factors (Gatersleben et al., 2002; Moll et al., 2005). Understanding the influences of psychological factors and socio-demographics on direct and indirect energy curtailment behaviors would inform policy models and allow the formulation of energy-saving programs for different socio-demographic groups (Ehrhardt-Martinez, 2008). Especially for indirect energy curtailment behavior, Abrahamse and Steg (2009) emphasized that if the aim is to encourage households to consume products with low energy use per unit, indirect energy use and factors related to it must be examined. However, no recent China studies have explored and compared the effects of psychological factors and socio-demographic characteristics on both direct and indirect energy curtailment behaviors. Thus, the current study aims to expand the existing body of knowledge in this area.

Attitude is identified as an important predictor of behavior because it represents the positive or negative evaluation of an individual regarding his or her particular behavior. With regard to

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