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RESEARCH ARTICLE

Different sources of rural household energy consumption and influencing factors in Dazu, China

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Abstract

Rural household energy consumption is an important component of national energy consumption. This paper explores the rural household energy consumption status and influencing factors on different sources of rural household energy consumption in western China. Using data from a survey of 240 households conducted in 2017, this study finds that rural households' energy consumption structure in the study area is a combination of traditional biomass energy and commercial energy sources. Fuelwood is the most commonly used fuel in the study area, while modern energy sources only occupy a low proportion. Rural household energy consumption is influenced by various factors. Individual perceptions of climate change, social trust and networks, and households' socio-economic and demographic factors (gender, age, education, income per capita, household size, household location, and number of household appliances) are identified as having significant effects on rural households' consumption of biomass and commercial energies. The research results provide implications for policy makers to formulate related rural energy policies to improve the rural energy consumption structure and future energy policy design in China and other developing countries.

Keywords Energy consumption · Rural household · Biomass energy · Commercial energy · China

Introduction

Energy plays an important role in human society and economic development (San et al. 2012). The irrational use of energy has led to environmental pollution and unsustainable development (Guo et al. 2018). In China, with the rapid economic development and improvements in living standards, households' energy consumption and the proportion of total energy consumption used by households have been rapidly increasing (Ding et al. 2017). China is the biggest developing country in the world, and almost one-half of its population lives in rural areas (Liu et al. 2013). How to improve the energy efficiency and reduce the energy consumption of rural households is an important policy issue in China.

Energy behaviors and energy consumption decisions are a complex, cognitive, and social processes (Kowsari and Zerriffi 2011). A better understanding of the vital factors influencing household energy consumption practices is of great importance for policy makers to design better policies (Han et al. 2018). There have been some previous attempts on analyzing the factors that influence rural households' energy use, e.g., Howells et al. (2005) for an African village, Ekholm et al. (2010) for the case of India, and Sapci and Considine (2014) for households in Wyoming, USA. However, due to the complexity of energy consumption decisions, the factors likely to affect rural households' decisions on energy consumption may be different in different countries or regions within a country (Pachauri and Jiang 2008; Hisali et al. 2011; Lange et al. 2014). Therefore, more location- or country-specific empirical studies on the factors that determine rural household energy use behaviors are needed (Ding et al. 2017).

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The energy consumption status and structure in rural areas have a huge impact on the economy and on the living standards of rural residents (Han et al. 2018). Biomass energies, including fuelwood, crop residues, straw, and livestock dung, have adverse consequences for the climate, environmental sustainability, and human health (Nansaior et al. 2013; Song et al. 2018). In China, there were 104 million people who died prematurely from indoor air pollution caused by solid fuel combustion, accounting for 12.5% of the premature deaths in 2010 (Wang and Jiang 2017). With the growth of the rural population, the problem will continue to worsen. Modern, high-efficiency, clean, and safe energy could provide local rural households with better livelihoods and living standards (Chen et al. 2016). Consequently, it is well accepted that a switch from traditional biomass energy to modern energy could significantly improve the quality of life and reduce the negative impacts of biomass energy on human health and the environment. However, switching from traditional biomass energy to modern fuels is not a simple unidirectional process (Wang and Jiang 2017). The understanding of household energy consumption from different energy sources and their influencing factors is still limited (Chen et al. 2016).

The main objective of this study was to investigate rural household energy consumption status and to explore the factors influencing rural household consumption of different energy sources (modern commercial energy and traditional biomass energy) in western China. This study can add to the existing research for a better understanding of the influencing factors on energy consumption behavior of rural households, comparing traditional biomass energy and modern commercial energy, which is important for the government to develop a sustainable rural energy policy and improve the structure of rural households' energy consumption.

The remaining structure of this paper is as follows. The "Methods and materials" section includes a description of the study area, the survey design, data collection, and data analysis. The "Results and discussion" section reports the empirical results and discussions. The final section summarizes the conclusions of the research and provides implications for further rural energy policy design in China and other developing countries.

Methods and materials

The study area

This study used Dazu District (105° 28′~106° 2′ E, 29° 23′ ~29° 52′ N) as the study area. It is located in the western suburb of Chongqing Municipality, which is one of the four municipalities directly controlled by the Central Government of China. Dazu District has a typical subtropical humid monsoon climate with an average annual precipitation of 1090 mm. The annual average temperature is 17 °C, and the average annual relative humidity is 85%. In 2016, the total population of Dazu was 1064.2 thousand, of which the agricultural population accounted for 55.16%. The majority of the people live in rural areas; thus, the rural areas can be expected to play an important role in the energy transition in this area. With rural development, a large increase in household energy consumption can be expected. To the best of our knowledge, no one has studied the energy use status in this area before.

Possible factors influencing energy consumption

The existing literature indicates that various factors may affect rural households' energy consumption practices. Based on empirical findings in the existing literature, this paper uses some similar variables to study the factors that may influence Chinese rural households' energy consumption decisions. The following issues are of particular interest.

Firstly, cognition is an important factor affecting individual behavior. Specifically, McCalley (2006) and Peng et al. (2010) argue that cognition is an important factor that affects the behavior of energy consumption. Rural energy consumption intensifies the CO_2 emissions and brings negative influence to climate change (Venkataraman et al. 2005). Improving energy efficiency is considered to be an important option for meeting energy and climate targets in many countries (Matsumoto and Omata 2017; Craig 2018). Thus, farmers' cognition of climate change and its adaptation may have an effect on their energy use decisions.

In the past decades, the literature of environmental policy and management has successfully introduced the concept of social capital (Grootaert et al. 2004). Social capital has been found to have influences on individuals' environmental behaviors (Pretty 2003; Jones et al. 2010). Consequently, it is important to understand the influence of an individual's social capital on his or her decisions of energy use. Social trust and networks are important components of social capital. Adger et al. (2003) argued that higher trust may enhance the opportunities for climate change adaptation. The value of social networks is in both facilitating trustworthiness and contributing to the possibility of exchanging information (Woolcock and Narayan 2000). Thus, farmers' social trust and networks may have an effect on farmers' energy consumption practices.

Finally, some studies have found that interviewees' socio-economic and demographic factors such as gender, age, education, household size, and income degree have an influence on their energy decision-making behaviors (Wang et al. 2017). Based on the content of this study, in addition to farmers' socio-economic factors, this paper takes into account the technical knowledge level and family location of farmers, both of which can reflect the ability of farmers to obtain information. At the same time, the number of household appliances could be associated with their energy use.

Survey design

To carry out this study, the research team developed and conducted a questionnaire survey, which was designed based on literature reviews. The questionnaire was validated by a group of researchers and experts on rural energy use. A pilot study was conducted to test the adequacy and accuracy of the questionnaire. Some modifications were made afterwards to make the instrument easy to be understood.

The survey questionnaire mainly contained four sections: (1) Respondents' knowledge and perceptions of climate change and its adaptation; (2) social factors, including social trust and social networks; (3) energy consumption behavior; and (4) socio-economic factors.

In the first section, a few questions were asked regarding the respondents' knowledge and perceptions of climate change and its adaptation. Respondents were asked whether they knew about climate change and whether their individual energy use behavior would affect climate change or not. Respondents were asked to express the extent of their agreement with several statements that climate change had severely affected their daily life and that the costs of climate change adaptation measures were high, on a Likert scale from 1 (strongly disagree) to 5 (strongly agree).

The second part of the questionnaire included questions relating to the measurement of social trust and social networks. Social trust concerns trust towards people in general or towards specific social groups (Uslaner and Conley 2003). Institutional trust is people's trust in functioning institutions in a community (Petzold and Ratter 2015). Nine questions were asked to examine the respondents' generalized and particularized trust. The respondents were asked to indicate their levels of trust in the central government, local government, village committee, judges and policemen, medical personnel, most people in society, friends, neighbors, and relatives. All questions were measured on a 5-point Likert scale, where 5 referred to "completely trust" and 1 to "completely distrust." The respondents' social networks and civic participation were measured through three questions. First, the respondent was asked whether his family name was the major surname in the village. The "Big surname" has become a type of social force. If the respondent belongs to the "Big surname," it might mean that there would be many people who can help him if needed. The respondents were asked whether they participated in any agricultural cooperatives and whether they were a member of the Communist Party.

There are eight main types of energy sources for rural households in the study area: electricity, coal, LPG (liquefied petroleum gas), gasoline, diesel, biogas, straw, and fuelwood. The respondents were asked to indicate what types of energy and how much energy were consumed in the past year. The biomass energy used in the study area includes biogas, crop straw, collected fuelwood, and livestock dung produced by farmers' livestock. The commercial energy consists of electricity, coal, LPG, gasoline, and diesel. To facilitate a unified accounting, this paper converted energy into standard coal equivalent (kgce) according to the reference table of the various energy discount coal released by the *China Energy Statistical Yearbook* (NBS 2016).

The last section recorded some demographic information concerning age, gender, education and income level, household size, and family location.

Data collection

The field survey was carried out by the research team in July 2017. The study adopted a multistage stratified random sampling technique. In the first stage, the research team randomly selected two townships from Dazu District based on the township scale, population size, and geographical location. They were the towns of Zhongao and Sanqu. In the second stage, the research team randomly selected three villages in each town. They were villages Changping, Banqiao, and Shuixing of Sanqu Town and villages Mingyue, Shuangxi, and Sanqiao of Zhongao Town. The natural and socio-economic characteristics of the chosen villages can represent the overall situation of Dazu District in general. In the third stage, 30 to 50 households were randomly selected in each village according to the population size of the village, and the farmers' availability and willingness. Respondents in this study were household heads or family decision-makers. The face-to-face interview survey method was used. Before the survey, interviewers were well-trained by our research team, and simulation exercises were organized to examine the interview skills and process. Finally, a total of 240 surveys were conducted. After censoring for missing and inconsistent responses, 232 responses were valid for further analysis.

Data analysis

The qualitative and quantitative information gathered was edited, coded, and analyzed using Excel® spread sheets and Stata 13 statistical package software (StataCorp 2013. Stata Statistical Software: Release 13. College Station, TX, USA). This study ran a series of models to investigate the factors influencing rural households' energy consumption decisions. The dependent variables in this study are the amounts of commercial energy and biomass energy used by rural households. Since the standardized coal equivalent amount of commercial energy consumption is a continuous variable, this paper employed the ordinary least square (OLS) model for analysis. Because the standardized coal equivalent amount of biomass is a restricted contact variable, the Tobit model is used to identify the factors on biomass energy consumption decisions. The explanatory variables included farmers' cognition, social trust, and some socio-demographic factors.

Results and discussion

Demographic profile of the sample

The descriptive statistics of our sample are presented in Table 1. Our randomly selected respondents have diverse socio-economic characteristics, such as age, education level, household size, and income. Approximately 56% of our sample was male. The typical respondent was 57 years. Roughly half (51.28%) of the sample was 60 years old or above. This is because most of the young people from rural households choose to work in the cities, leaving their children and the elderly at home. On average, the respondents had a six-year educational level (primary school). Specifically, approximately 25% of the respondents reported that they had no formal education at all. Nearly half of the respondents (42%) completed their primary education. There were 22% and 8% of the respondents who had attained a junior high school and high school education, respectively. Only 3% of the sample had obtained a tertiary qualification. The overall average household size of the sampled respondents was 3.69 people. Approximately 47% of our respondents had a family with 3 to 5 people living together. The average income per person per year was approximately 12 thousand CNY (1844.36 USD), which is not much different from the provincial average of 13.1 thousand CNY/year (2015.38 USD/year). The representativeness of the sample was verified with data from the Chongqing Statistical Yearbook 2017 (recording the data of 2016).

The energy consumption structure

The energy consumption structure in the study area consisted of an integration of traditional biomass energy and modern commercial energy. An analysis of the results indicates that the energy consumption structure in the study area consisted of 76% biomass energy and 24% commercial energy. Hence, biomass energy dominates rural households' energy consumption and plays an important role in the study area. Wang and Jiang (2017) also pointed out that biomass energy is one of the most important energy resources in developing countries. Globally, 82% of the rural households in developing countries depend primarily on traditional biomass energy for heating and cooking (IEA 2013).

In terms of the various specific types of energy usage, the results show that firewood was the most important energy source for rural households in the study area, accounting for 75% of the total energy use and 98% of the biomass energy (see Fig. 1). This is mainly because the study area has rich forest resources, abundant wood-processing plants, and a high availability of fuelwood. The modern energy sources, such as electricity and gasoline, are not well utilized, with electricity accounting for 12% of the total energy use, which is in agreement with Yu and Guo (2016). Very few households use straw as an energy source. This is probably due to the fact the government's advocacy of returning straw to the soil. This finding is also in accordance with the existing literature, which reports that the proportion of straw in rural household energy consumption in Xinmi and Shanghang, China, is only 0.14% and 0.28%, respectively (Wang et al. 2017).

Table 1 Descriptive statistics of survey sample

Demographic variables	Category	Number	Percentage
Gender	Male	132	56.17
	Female	103	43.83
Age	Under 60 years old	114	48.72
	60 years old and above	120	51.28
Education	No formal education	59	25.21
	Primary school	99	42.31
	Junior high school	51	21.79
	High school	18	7.69
	College and above	7	2.99
Household size	0–2 people	79	33.76
	3–5 people	111	47.44
	6 people and above	44	18.8
Average income per person per year	4477 CNY and below	39	16.81
	4478–7462 CNY	77	33.19
	7463–14,925 CNY	86	37.07
	14,926–29,850 CNY	26	11.21
	29851CNY and above	4	1.72

Farmers' cognition of climate change and its adaptation

Our results show that the mean score of respondents' agreement that climate change had severely affected their daily lives was 3.94 (1 = strongly disagree; 5 = strongly agree), suggesting that the majority of our respondents had a perception of the effect of climate change. Specifically, 23.4% of respondents strongly agreed and 51.06% agreed that climate change had severely affected their lives. Respondents were found to be concerned about the costs of climate change adaptation measures (variable name: adopt_cost). When they were asked whether the costs of climate change adaptation measures were high or not, the majority of our respondents (69.79%) expressed their agreement.

Social trust and networks

This study employed the factor analysis method to analyze rural households' institutional, stranger, and acquaintance trust. The results are presented in Table 2. The value of KMO is 0.71 and the coefficient of Cronbach's alpha is 0.78, indicating that the scale has good reliability and validity. As seen from Table 2, farmers' social trust was classified into three principal factors, and the contribution rate adds up to 70%. This can reflect most of the information in the basic data and has strong representativeness and ideality. A further rotation was performed to obtain a rotated load matrix. The factor load reflects the degree of correlation between the principal component and the original indicator variable, and the greater the load value, the greater the degree of correlation. According to the summary and reflection of the information on each factor, farmers' trust in the central government, trust in the local government, trust in the village committee, trust in the judges and policemen, and trust in the medical personnel are the main components. Farmers' trust in friends, neighbors, and relatives is the second principal component, and farmers' trust in strangers is the third component. Based on the above results, this paper sets the three principal component factors as institutional trust factor, stranger trust factor, and acquaintance trust factor.

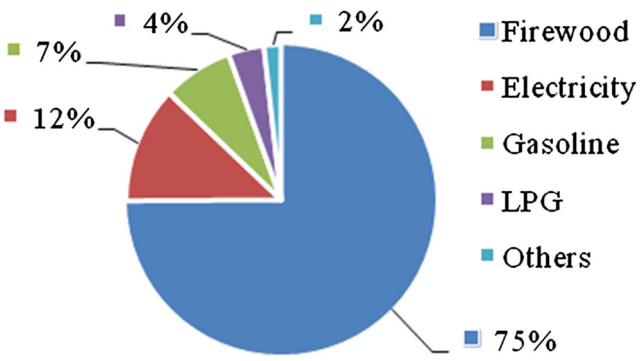

Fig. 1 Proportion of energy consumption structure

Regarding the social networks, 55% of the respondents stated that they were in the crowd of the "Big surname." Civic participation is also an important factor. The agricultural cooperative in China is an agricultural production model based on economic projects to achieve collective cooperation. However, our survey results show that only 9% of the respondents were a member of the agricultural cooperative. Twelve percent of our respondents were Communist Party members.

Factors determining energy consumption

The definitions of the dependent variables and explanatory variables used for our estimation as well as their major statistical values are reported in Table 3.

Table 4 presents the results of a set of estimations on the respondents' daily consumption of commercial energy and biomass energy. As shown in Table 4, most explanatory variables have the expected signs and are statistically significant.

The regression results show that respondents' perceptions of climate change and its adaptation have significant effects on biomass energy consumption. Respondents who thought climate change had a severe impact on their daily lives would use less biomass. If respondents thought the climate change adaptation costs are high, they would not consider climate change adaptations and use more biomass energy.

Our results indicate that trust in institutions, such as governments, is negatively related to household commercial energy and biomass energy consumption. This finding is in agreement with the results in psychology and sociology, which report a significant relationship between trust in institutions and a variety of energy-conserving behaviors (Sonderskov 2011; Volland 2017). However, trust in acquaintances has a positive effect on both biomass and commercial energy consumption. One possible reason for this is that the traditional Chinese countryside is a human-oriented society, and it maintains a high level of acquaintance trust, which can save transaction costs. Thus, farmers can collect fuelwood together and use more biomass energy. Our results also indicate that Bigname has a positive effect on biomass energy consumption. This is probably because wider networks can help them collect more fuelwood and result in more biomass energy consumption. However, the variable Bigname is negative and highly significant in the commercial energy model, suggesting that the respondent who had the big surname in the village would use less commercial energy. This is expected because respondents with more relatives would have more information and are more likely to use energy-efficient appliances. Furthermore, the estimation results show that whether or not the household head is a Communist Party member has a

Table 2 The measured means of trust and the factor loading after rotation

Social trust		Mean	Std. Dev.	Common factor			Contribution rate/%
				1	2	3	
Institutional trust	The central government	4.77	0.49	0.62	0.06	0.08	0.34
	The local government	4.30	0.82	0.86	0.04	0.06	
	The village committee	4.35	0.73	0.87	0.06	0.08	
	Judgers and policemen	4.22	0.71	0.76	0.15	0.15	
	The medical personnel	4.00	0.90	0.72	0.14	0.37	
Stranger trust	Most people in society	2.27	0.86	− 0.01	− 0.00	0.93	0.24
Acquaintance trust	Friends	3.86	0.67	− 0.04	0.83	0.17	0.12
	Neighbors	4.04	0.56	0.16	0.90	0.06	
	Relatives	4.16	0.51	0.10	0.80	0.16	

significant negative effect on their biomass energy consumption. In addition, if the respondents are members of an agricultural cooperative, their biomass energy consumption would increase because there are more places for them to use energy.

According to the regression results, gender has significant effects on household energy consumption. The positive signs of the gender coefficient indicate that no matter if it is commercial or biomass energy, men use more energy than women. Older household heads used less commercial energy and more biomass energy. This could be related to the traditional energy consumption custom of farmers, who rely on the solid biomass energy for a long time. Another explanation is that elderly people usually have more time to collect biomass and therefore increase biomass energy consumption. In addition, the education level of household heads has a positive coefficient value for commercial energy, whereas it has a negative coefficient value for biomass energy. This indicates that household heads with higher education levels are inclined to use less biomass and more commercial energy. This is likely because highly educated household heads have a better awareness of energy conservation and environmental protection, and their cost of biomass collection is relatively higher (Peng et al. 2010). Thus, education has a significant impact on changes in the energy consumption structure. The regression results show that rural households' knowledge on the agriculture-supporting policy has no significant effect on

Table 3 List of variables and descriptive statistics

Variable	Description	Mean	Std. Dev.
Dependent variable			
Commercial energy	Standard coal equivalent of commercial energy consumption	0.51	0.70
Biomass energy	Standard coal equivalent of biomass energy consumption	1.65	1.98
Controlled variable			
Climate impact	Climate change has severely affected your life (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)	3.94	0.78
Adopt cost	The costs of adopting climate response measures are high (1 = strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree)	3.89	0.82
Big_surname	Big surname in the village (yes = 1;no = 0)	0.54	0.50
Party_member	Communist party member (yes = 1; no = 0)	0.12	0.32
Agri_cooperative	Agricultural cooperative member (yes = 1; no = 0)	0.09	0.29
Gender	Male = 1, female = 0	0.56	0.50
Old_people	Old people(≥ 60 years old) (yes = 1; no = 0)	0.51	0.50
Education	Below junior high school = 0, junior high school and above = 1	0.32	0.47
Agri_policy	Knowledge of the agricultural supporting policy (yes = 1; no = 0)	0.67	0.47
Hhsize	Household size	3.69	1.72
Location	Family location (town perimeter = 1; otherwise = 0)	0.43	0.50
Appliance	Number of household appliances	3.49	2.07
Per_income	Household income per capita (10000CNY/year)	1.20	1.02

Table 4 Factors on rural household energy consumption

Variable	Commercial energy model		Biomass energy model	
	Coef.	Std. Dev.	Coef.	Std. Dev.
Climate_impact	0.06	0.06	− 0.55***	0.19
Adopt_cost	− 0.05	0.05	0.39**	0.19
Institutional trust	− 0.14***	0.04	− 0.16*	0.15
Acquaintance trust	0.06*	0.04	0.30***	0.15
Stranger trust	− 0.08**	0.04		
Big_surname	− 0.21***	0.09	0.48*	0.30
Agri_cooperative	− 0.12	0.16	1.99***	0.54
Party_member	− 0.14	0.15	− 1.79***	0.53
Gender	0.18**	0.09	0.37*	0.32
Old_people	− 0.24***	0.10	0.75**	0.34
Education	0.15*	0.11	− 0.87**	0.39
Agri_policy	0.37***	0.10	0.26	0.35
Hhsize	0.03*	0.03	0.11*	0.09
Location	− 0.07	0.09	− 1.55***	0.33
Appliance	0.06***	0.03	0.10*	0.09
Per_income	0.04*	0.05	− 0.04*	0.15
Constant	− 0.02	0.34	1.52	1.19
Log likelihood			− 413.023	
LR chi^2 statistics			81.29***	
R^2	0.27			
No. of observations	232		232	

*$p < 0.1$; **$p < 0.05$; ***$p < 0.01$

biomass energy consumption; however, it results in more commercial energy consumption. This may be because agriculture-supporting policies are primarily advocated for agricultural production, which needs more commercial energy, such as electricity or diesel.

Our results show that the coefficients for the household size variable are positive and significant, implying that the number of family members has a positive effect on the consumption of household energy. This finding is in accordance with empirical findings in the literature that the increasing household size significantly enhances the consumption of energy because larger households require more energy (Liu et al. 2013; Han et al. 2018). In terms of household location, it comes as no surprise that the variable "location," indicating the family location within a town's perimeter or not, is negative and significant in the biomass energy model, implying that rural households living within a town's perimeter would use less biomass energy. This finding is as expected since households who live in mountainous areas have better access to fuelwood and thus use more traditional biomass energy (Song et al. 2018). The significant and positive signs for the coefficients of the number of household appliances in this study suggest that families with more household appliances would use more commercial energy and biomass energy. Han et al. (2018) also found that home appliances are positively and significantly related to energy consumption. Finally, the estimated coefficient for income per capita is significantly negative in the biomass energy model but positive in the commercial energy model, indicating that families with lower incomes prefer to use biomass energy rather than commercial energy. This is in accordance with the theory and previous studies on household fuel choice results, as lower-income families prefer the adoption of biomass fuels and hence less use of modern energy sources (Démurger and Fournier 2011; Wang et al. 2017; Song et al. 2018). Barnes et al. (1997) also pointed out that households will transition from biomass energy to modern fuels as their incomes grow.

Conclusions

To meet the needs of climate change mitigation and rural sustainable development, it is vitally necessary for China to promote fuel switching from the use of traditional biomass energy to modern energy sources. To better understand the energy consumption behaviors of rural households in the energy transition, this study takes Dazu District in the municipality of Chongqing as the empirical context in which to investigate the rural household energy consumption status and

to explore the determinants of modern commercial energy and traditional biomass energy usage.

Our empirical results indicate that the rural households' energy consumption structure is a combination of traditional biomass energies and commercial energy sources. Traditional biomass energy is the main component. The proportion of fuelwood is 75%, while modern energy sources only occupy a low proportion.

Rural household energy consumption is influenced by various factors. Our estimation results show that respondents' perceptions of climate change and its adaptation have significant impacts on energy consumption. If people are aware of the effects of climate change, they will reduce their use of biomass and may turn to commercial energy. If people think that the costs of adapting to climate change are high, their willingness to reduce biomass energy consumption will be weakened. Social networks also have significant impacts on the energy use of rural households. Households with more social networks are more willing to use biomass energy. In terms of the effect of institutional trust, the results indicate that households who tend to trust the institutions more would have less energy consumption, compared with their less trusting counterparts. In addition, rural households' socio-economic and demographic factors (such as gender, age, income, household size, and education level) have significant effects on their consumption of commercial energy and biomass energy. Old people prefer to use traditional biomass energy over commercial energy sources. The well-educated household heads tend to increase the consumption of modern commercial energy, whereas those households where the head has a lower education level use more traditional biomass energy. Household income per capita is an important factor affecting energy consumption and is an essential driver behind the energy transition.

The above findings provide some implications for rural household energy policy in China and other developing countries. First, the proposed energy policies should adapt to local conditions. It may take time for rural households to change their energy consumption habits. The government should advocate using biomass properly and effectively. Some new technologies can be exploited to convert traditional biomass into gas, solid, or liquid forms with a higher grade, which are similar to or better than coal to improve energy efficiency. Second, since the education level of household heads has proved to be a significant factor influencing household energy consumption, the education should be strengthened to improve rural residents' awareness of energy conservation and health protection. Education programs that enhance their preference for adopting new energy-saving technologies and appliances could also be implemented by the government. Third, income level is an important factor affecting energy consumption. Local governments can provide job opportunities to enhance the incomes of rural households or provide subsidies for clean or renewable energy to reduce the cost of using them. In addition, rural households' trust attitudes towards institutions have a significant and negative effect on energy consumption; thus, policies that aim to enhance the level of trust in institutions are needed.

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