How "Informing Consumers" Impacts Willingness to Pay for Renewable Energy Electricity in China

Runqing Zhu, School of Management, China Institute for Studies in Energy Policy, Xiamen University, Fujian, China.
Yufang Chen, School of Management, China Institute for Studies in Energy Policy, Xiamen University, Fujian, China.
Boqiang Lin, School of Management, China Institute for Studies in Energy Policy, Xiamen University, Fujian, China.*
https://orcid.org/0000-0002-1308-400X

ABSTRACT

This paper finds that informed residents are more willing to support renewable energy development. Respondents with a higher level of participation in renewable energy planning, satisfaction with the implementation of renewable energy policies, as well as recognition of the high cost of renewable energy are more willing to use renewable energy. They are willing to pay more for renewable energy power, which means that respondents with more green information (renewable energy) are willing to pay more for renewable energy electricity. Although respondents are more willing to use voluntary payment mechanisms, they are more likely to pay more for renewable energy power under the mandatory payment mechanism. There is a large gap between the actual green power purchase behavior of Chinese residents and the expected WTP, mainly because there are many problems in the voluntary subscription mechanism for green power certificates. Finally, this paper provides targeted policy recommendations for policymakers.

KEYWORDS

Mandatory and Voluntary Payments, Renewable Energy Electricity, Tradable Green Power Certificate, Willingness to Pay, Willingness to Use

1. INTRODUCTION

With urbanization and industrialization, social development has become increasingly dependent on electricity and has led to an increasing proportion of electricity consumption in terminal energy consumption in recent years. According to data from the National Bureau of Statistics, the share of thermal electricity generation accounted for about 72% in 2019 in China. Moreover, the CO_2 emissions from coal-fired power account for more than 34% of the total CO_2 emissions in China (Chen and Lin, 2020a). China faces enormous pressure to reduce emissions and has set the following goals. Firstly, increase the proportion of non-fossil energy consumption to 20% by 2030. Secondly, reduce the intensity of CO_2 emissions by 60%-65% before 2030 compared with 2005's (Chen and Lin, 2020b). Renewable energy electricity has the same electricity use value as thermal power generation and has more environmental and ecological benefits (Guo et al., 2014). Therefore, increasing the proportion

DOI: 10.4018/JGIM.309378
*Corresponding Author

of renewable energy in electricity generation can not only meet the demands of social and economic development but also alleviate environmental problems and delay the process of climate change (Lin and Chen, 2020; Ramos and Rouboa, 2020; Bui and Tseng, 2022).

Renewable energy electricity is usually more expensive than thermal power. Additionally, the capital recovery time required for developing renewable energy is longer than conventional energy, and financing renewable energy projects is more difficult. Therefore, the development of renewable energy requires huge investments and many subsidies. From a long-term perspective, demand-side measures are effective to promote renewable energy power consumption and stimulate innovation in renewable energy technologies (Lin and Chen, 2019b; Dubey et al., 2022). For example, a mandatory mechanism that forces everyone to pay additional taxes and surcharges or a mechanism that voluntarily subscribes to green electricity certificates, (Xie and Zhou, 2018; Knapp et al., 2020) is usually recommended. Moreover, public acceptance is another important factor which affects the development of renewable energy and the innovation of renewable energy technologies (Wüstenhage et al., 2007).

In China, the feed-in tariff policy is used to support renewable energy development and the continuous promotion of renewable energy technology innovation in reducing costs. This part of the subsidy comes from the government's renewable energy tariff surcharge subsidy on consumers. Currently, for electricity other than electricity for agriculture and residents, the collection standard for renewable energy tariff surcharge subsidy has been raised to 0.019 yuan/kWh. Nonetheless, the cumulative revenue from renewable energy tariff surcharge subsidy during the last 12 years from 2006 to 2017 exceeded 450 billion yuan, but still existed a gap of about 110 and 200 billion yuan in 2017 and 2018, respectively (Chen and Lin, 2020a). Relying on subsidies to develop renewable energy is not a long-term solution. Therefore, in July 2017, the China Green Power Certificate Subscription Trading Platform was launched to alleviate the pressure of subsidy demand. China's green certificate trading market has been officially in operation for about three years and is still in its experimental stage. The policy mechanism's design has various deficiencies in benchmark prices, basic quotas, and fines, as the transaction status of the green power certificates does not operate as expected (Song et al., 2020). As of June 18, 2020, 2177 users participated in the China Green Power Certificate Subscription Platform to purchase green power certificates, and 37,816 green power certificates were subscribed. Enterprises purchased most green power certificates. The government had successively issued relevant renewable energy quota trading plans to encourage enterprises to purchase green power certificates (Zhao et al., 2019). Although purchasing a green power certificate is currently a model for Chinese residents to prove that they consume renewable energy electricity, only a few of the residents are concerned about the renewable energy industry purchasing green power certificates. It shows that Chinese residents have insufficient motivations to participate in renewable energy electricity consumption.

In theory, with the popularization of sustainable development, more and more residents are willing to pay a certain fee for renewable energy electricity (Zhang and Wu, 2012; Guo et al., 2014; Chan et al., 2015; Arega and Tadesse, 2017; Zhou et al., 2018; Yang et al., 2018; Koto and Yiridoe, 2019). Based on Ngan et al. (2019), residents with the willingness to use a certain product or service tend to pay higher fees. Therefore, studying residents' willingness to use (WTU) and willingness to pay (WTP) for renewable energy electricity is of great significance for evaluating investment projects and revising the long-term development goals of renewable energy electricity. According to data from the National Bureau of Statistics, residential electricity consumption accounted for nearly 15% of the entire society in 2019 in China. With the continuous rise in household electricity consumption, attention should be paid to the issue of renewable energy power consumed by residents. This study answers the following questions: (1) What factors affect residents' WTU for renewable energy electricity? (2) What factors affect residents' WTP for renewable energy electricity under the baseline scenario, the WTU for renewable energy electricity scenario, the compulsory payment mechanism scenario, and the voluntary payment mechanism scenario? What are the mean values of WTP under these scenarios? (3) According to the mean value of WTP calculated under this paper's voluntary payment mechanism scenario, how many green power certificates are residents expected to purchase in one year? (4) Why is there a big gap between residents' actual green power purchase behaviors and the expected WTP? This paper investigates the residents' WTU and WTP for renewable energy electricity in four first-tier cities (Beijing, Shanghai, Guangzhou, and Shenzhen) and determines the factors that affect their WTU and WTP, especially residents' preference for payment mechanisms and their WTP under different payment mechanisms. This paper may provide important information for renewable energy policymakers.

The main innovations of this paper are as follows. First, unlike previous literature on the WTP, this paper explores the factors that affect residents' WTU for renewable energy electricity. Moreover, since residents' WTU, to a certain extent affect the WTP (Ngan et al., 2019), this paper also discusses the WTP under the WTU. Second, different payment mechanisms may also affect residents' WTP (Guo et al., 2014; Akcura, 2015). Therefore, based on a sample of four first-tier cities in China, this paper compares the WTP under the two payment mechanisms of compulsory payment and voluntary payment and investigates the impact of residents' preference for payment mechanisms on the WTP. Also, when selecting the influencing factors, this paper does not only consider the residents' socioeconomic characteristics but also considers their cognitions and behaviors, such as environmental protection behavior, knowledge of renewable energy, participation in renewable energy planning, satisfaction with the implementation effect of renewable energy policies, trust in government environmental governance, and the recognition of the high renewable energy electricity cost. Besides, the knowledge of renewable energy and participation in renewable energy planning is also considered the residents' access to green information (Zhang and Wu, 2012; Hast et al., 2015; Guo et al., 2015; Kardooni et al., 2016; Xie and Zhao, 2018; Kardooni et al., 2018). Moreover, our study compares the mean WTP estimated with previous literature results and calculates the residents' expected purchasing capacity of green power certificates in one year. This paper attempts to analyze the reason there is a big gap between residents' actual green power purchase behavior and expected WTP. Finally, this paper proposes targeted policy recommendations based on the analysis results.

The remainder of this paper is as follows: Section 2 briefly reviews the existing research. The survey design, data description, and method used in this paper are shown in Section 3. In Section 4, this paper presents the results and discussion. Section 5 concludes and provides some targeted policy suggestions.

2. LITERATURE REVIEW

Residents with the WTU for a certain product or service tend to pay higher fees (Ngan et al., 2019). Therefore, before discussing WTP, this paper first discusses WTU. Reviewing previous literature, Kardooni et al. (2016) emphasized the importance of residents' intentions to use renewable energy technologies. The discussion on the WTU for renewable energy can provide some reference for policymakers. Viklund (2004) found that residents with higher levels of environmental knowledge were eager to use green technologies in Australia. Reddy and Painuly (2004), and Hartmann and Apaolaza Ibanez (2007) found that cost impacts intentions to use renewable energy. Huijts (2014) surveyed and found that residents' trust in the actors in charge of technology affected their intentions to use renewable energy. Kardooni et al. (2018) found that in addition to residents' socioeconomic characteristics, residents' views on the cost of renewable energy, knowledge of renewable energy, and trust in government actions affected their renewable energy usage.

In the analysis of public product values, such as new energy vehicles (Lin and Tan, 2017), haze mitigation (Ouyang et al., 2019), charging facilities (Tan and Lin, 2020), and green electricity (Xie and Zhao, 2018) WTP is widely discussed. The contingent valuation (CV) method is widely used in assessing the value of public products (Oerlemans et al., 2016), and is also a very powerful method to provide conclusions to policymakers (Lin and Tan, 2017). There are four popular techniques to measure WTP, such as bidding games (BG), open-ended (OE), dichotomous choice (DC), and payment card (PC). In general, the BG technique proposes the WTP value accepted or rejected by the interviewee and continues to increase or decrease the bid according to the interviewee's decision (Chan et al., 2015), which is used in the face-to-face survey and telephone interview (Tan and Lin, 2020). OE technique requires each interviewee to choose their WTP value without any restrictions or prompts, which is a more efficient method but might be far from the real value (Zhou et al., 2018). DC technique includes single-bound dichotomous choice (SBDC) and double-bound dichotomous choice (DBDC). SBDC means that each respondent will receive a randomly assigned bid and choose acceptance or rejection. DBDC refers to providing a second bid for the respondent based on the respondent's response to the first bid. However, the DC technique might lead to lower statistical efficiency and anchoring effect (Zhou et al., 2018). In the PC technique, respondents select (different) values from the same predefined and ordered lists. Although the bidding price impacts the PC technique, it can successfully elicit the WTP amount of potential respondents and reduce the difficulty when answering questions (Zhang and Zhu, 2012; Zhou et al., 2018). Therefore, this paper uses the PC technique of the CV method to measure WTP.

WTP for green electricity may show significant differences among consumers in various countries/regions with different economic developments, environmental policies, cultural backgrounds, and social customs (Xie and Zhao, 2018). WTP for green electricity may also show significant differences under different WTP measurement methods (Oerlemans et al., 2016). In the recent literature, Zhang and Wu (2012) investigated the differences in demographic variables that affected the varying values of WTP using the payment card technique based on a sample from Jiangsu province in China and observed that the mean WTP ranged between US$ 1.15 and 1.51 per month. Based on a sample from Beijing in China, Guo et al. (2014) compared the WTP under mandatory and voluntary payment vehicles, while applying the dichotomous choice technique to measure WTP, and obtained the mean WTP to range from US$ 2.7-3.3 per month. Based on the sample in South Africa, Chan et al. (2015) compared the double-bounded dichotomous choice and open-ended techniques and observed the mean WTP under the double-bounded dichotomous choice technique to be US$ 3.75 per month, while the mean WTP under open-ended technique was US$ 13.75 per month. Lee and Heo (2016) investigated data on South Korea and estimated a WTP of US$ 3.21 per month. Based on the Tigray, northern Ethiopia sample, Arega and Tadesse (2017) used a double-bounded dichotomous choice technique to measure WTP and obtained the mean WTP (US$ 0.66 per month). They further found that income, gender, and distance to alternative energy markets impacted WTP. Using data on Tianjin in China, Xie and Zhao (2018) found that the knowledge of renewable energy, trust in government, and behavior positively affected WTP as the mean WTP was US$ 4.76 per month. Based on the sample of Atlantic Canada, Koto and Yiridoe (2019) adopted a double-bounded dichotomous choice technique to measure WTP and found that residents were willing to pay 14% more per month in energy bills for wind power.

The market cost of renewable energy electricity is higher than traditional energy (Sundt and Rehdanz, 2015), hindering the widespread use of renewable energy. There are currently two payment mechanisms that support residents' renewable energy electricity generation investments. One is a mandatory mechanism that forces everyone to pay fixed prices, additional taxes, surcharges, purchase fixed quotas, etc. The other is a scheme where entities voluntarily subscribe to green electricity certificates, voluntary donations, etc. The reliability of the mandatory payment mechanism is that it can force everyone to pay. However, if they do not believe that the funds raised will be used for the funded public products but other products, it will lead to a negative reaction (Akcura, 2015). Voluntary payment mechanisms may induce interviewees to overstate their true WTP valuation, but they may pay less than the prescribed amount (Akcura, 2015). However, under the voluntary payment mechanism, the valuation of the interviewees may be greatly reduced since those who benefit without paying may think it is unfair (Kato and Hidano, 2002).

WTP may be affected by the type of payment mechanisms used in the survey, called the "payment method effect" in the CVM literature. Only a few studies have investigated the impact of payment mechanisms on the WTP valuation of respondents. Even fewer studies also investigate the impact of payment mechanisms on respondents' WTP valuation for green electricity. Wiser (2007) and Guo et al. (2014) investigated the US and China's Beijing, respectively. They all indicated that the WTP under the mandatory payment mechanism was higher than that under the voluntary payment mechanism, and there was an impact of "participation expectations" on the stated WTP. Based on the sample of the UK, Akcura (2015) found that though respondents preferred the voluntary payment mechanism, they would be more certain of their WTP under the mandatory payment mechanism. Therefore, the respondents' preference for payment mechanisms will also become one factor that affects their WTP valuation.

The current literature mostly proves the relationship between attitude and WTP. This paper analyzes the relationship with WTP from the perspective of residents' cognition, behavior, and mechanism preference. Based on the sample of four first-tier cities in China, this paper discusses WTPs under the WTU for renewable energy electricity, under the mandatory payment mechanism, and under the voluntary payment mechanism, as well as tries to compare residents' WTP with actual purchase behavior. Through the findings from the above research objectives, the results of previous studies are supplemented.

3. SURVEY DESIGN AND METHOD

3.1. Survey

Our questionnaire was distributed to the internet platform "Questionnaire Treasure," a professional data research platform covering more than 1 million users in 346 cities in China. This internet platform is developed by Guangdong Digital Intelligence Technology Company and is also a platform for online surveys for public opinions based on mobile phones. This internet platform scores respondents based on their completeness and frequency of use, as users with lower scores can be excluded from answering the questionnaire to a certain extent, which can ensure the quality of the questionnaire. Moreover, most groups with different genders, ages, educational backgrounds, and income levels can access the "Questionnaire Treasure" on their smartphones. Therefore, it is believed that the questionnaire respondents were randomly selected. Compared with traditional face-to-face or mail questionnaires, the advantages of online questionnaires are: First, it can ensure the randomness of questionnaires and reduce sample selection bias. Second, respondents will not be affected by the interviewer's emotions, and also present a relatively lower survey cost (Lin and Wu, 2018). Many studies have used the "Questionnaire Treasure" to collect survey data, such as Du and Lin (2017), Lin and Tan (2017), Lin and Wu (2018), Xu and Lin (2020), and Tan and Lin (2020).

The questions in this questionnaire can be divided into two parts. The first part includes ten questions, which are related to the respondent's demographic characteristics, cognition, and behavior, such as gender, age, education level, income, the number of family members, environmental protection behavior, knowledge of renewable energy, the participation in renewable energy planning, satisfaction with the implementation effect of renewable energy policies, trust in government environmental governance, recognition of high renewable energy electricity cost, and preference for the payment mechanisms. The second part includes WTU and WTP. This paper obtains the respondents' WTU for renewable energy electricity through the following questions.

If renewable electricity can be used, would you like to use it?

A. No B. Yes

In addition, this paper adopts two modes of mandatory and voluntary payment on the issue of WTP. Among them, 3215 respondents answered the question of WTP under mandatory payment, and 2212 answered the question of WTP under voluntary payment.

1. Mandatory payment

   (1) If you need to pay more for using renewable energy power, are you willing to pay?
      A. No B. Yes

Whether the respondent chooses "Yes" or no, everyone must pay the fee. The following item must be answered:

(2) What maximum fee are you willing to pay for renewable energy electricity per month?

   A. 2 yuan B. 10 yuan C. 20 yuan D. 50 yuan E. 100 yuan F. 200 yuan
      2. Voluntary payment
(1) If you need to pay more for using renewable energy power, are you willing to pay?
   B. No B. Yes

If the respondent chooses "Yes," the following item must be answered:

(2) What maximum price are you willing to pay for renewable energy electricity per month?

   A. 2 yuan B. 10 yuan C. 20 yuan D. 50 yuan E. 100 yuan F. 200 yuan

This paper invites well-known experts and scholars in the field of China's energy economic research to discuss the setting of the questionnaire. In addition, this paper also conducted a pretest. Based on the valuation of the WTP given by the interviewee, this paper selects the most frequent prices selected by the respondents and combines the previous literature, such as Guo et al. (2014) and Xie and Zhao (2018), to finally determine the above maximum prices.

3.2. Data Description

A total of 5427 respondents filled out the questionnaire about WTP for renewable energy electricity. This paper excluded those samples in which the respondents were aged 15 and below but had already obtained college degrees or above, the respondents indicated they did not use electricity, and the respondents did not review the questions seriously (for example, missing responses). This paper also excluded the samples of IDs for the mandatory payment mechanism, which are the same as IDs for the voluntary payment mechanism. Finally, 4300 respondents were used in our study.

3958 respondents were willing to use renewable energy electricity, accounting for around 92.05%. 3616 respondents were willing to pay for renewable energy electricity, making up about 84.09%. About 85% of the respondents preferred voluntary payment. This paper sets a choice question with six options. Under the mandatory payment, 23.5% of respondents were willing to pay 20 yuan per month for renewable energy electricity, making it the largest ratio. About 22.27% of the respondents were willing to pay 10 yuan per month for renewable energy electricity, while 20.1% of the respondents were willing to pay 50 yuan per month. Only 237 respondents preferred to pay 200 yuan per month for renewable energy electricity. Under voluntary payment, 27.24% of the respondents were willing to pay 20 yuan per month for renewable energy electricity, making it the largest ratio. About 23.69% of the respondents were willing to pay 10 yuan per month for renewable energy electricity, while 18.63%

were willing to pay 50 yuan per month. Only 69 respondents opted to pay 200 yuan per month for renewable energy electricity. Table 1 shows the summary statistics of the main variable in this paper.

Table 1. Summary statistics of the variable

Q		N	%
City	Beijing	1224	28.47
	Shanghai	1005	23.37
	Guangzhou	1147	26.67
	Shenzhen	924	21.49
Gen	Female	1523	35.42
	male	2777	64.58
Age	<= 15	69	1.60
	[16, 25]	1202	27.95
	[26, 45]	2772	64.47
	[46, 60]	205	4.77
	>= 61	52	1.21
Education	Junior middle school and below	92	2.14
	Senior school	853	19.84
	Bachelor	2985	69.42
	Master and above	370	8.60
Income	[0, 2000)	55	1.28
	[2000, 4000)	280	6.51
	[4000, 6000)	694	16.14
	[6000, 8000)	950	22.09
	[8000, 10000)	817	19.00
	[10000, 20000)	980	22.79
	>= 20000	524	12.19
Member	<=3	1523	35.42
	[4, 6]	2465	57.33
	[7, 10]	312	7.26
Behavior	None	30	0.7
	Seldom	299	6.95
	Occasionally	1672	38.88
	Often	1777	41.33
	Always	522	12.14
Knowledge	Completely ignorant	54	1.26
	Know little	343	7.98
	Generally	1805	41.98
	Know more	1656	38.51
	Completely know	442	10.28
Payment questionnaire	Mandatory	2119	49.28
	Voluntary	2181	50.72

Table 1 continued on next page

Table 1 continued

Q		N	%
Participate	Not participate	61	1.42
	Participate but no opinion	731	17.00
	Participate and put forward your own opinions	1919	44.63
	Participate and put forward more constructive comments	998	23.21
	Participate and put forward constructive comments on each planning process	591	13.74
Satisfaction	Completely dissatisfied	37	0.86
	Less satisfied	3.05	7.09
	Generally	1497	34.81
	Quite satisfied	1760	40.93
	Completely satisfied	701	16.30
Trust	Completely distrust	31	0.72
	Less trust	180	4.19
	Generally	1214	28.23
	Quite trust	1930	44.88
	Completely trust	945	21.98
Cost	Completely unacceptable	80	1.86
	Less acceptable	526	12.23
	Generally	1550	36.05
	Quite acceptable	1571	36.53
	Completely acceptable	573	13.33
Payment preference	Mandatory	645	15.00
	Voluntary	2655	85.00
WTU(Pooled)	No	342	7.95
	Yes	3958	92.05
WTP(Pooled)	No	684	15.91
	Yes	3616	84.09
WTP(Mandatory)	2 yuan	227	10.71
	10 yuan	472	22.27
	20 yuan	498	23.50
	50 yuan	426	20.10
	100 yuan	259	12.22
	200 yuan	237	11.18
WTP(Voluntary)	2 yuan	301	16.94
	10 yuan	421	23.69
	20 yuan	484	27.24
	50 yuan	331	18.63
	100 yuan	171	9.62
	200 yuan	69	3.88

3.3. Methodology

Firstly, the WTU for renewable energy electricity is a 0 or 1 dummy variable. If a linear probability model is used for estimation, there will be a deviation. Therefore, the binary logit or probit model is appropriate for this case (Hassen, 2018; Echaniz et al. 2019). Although both logit and probit are estimated by maximum likelihood estimation, the logit model is widely used because it has a relatively simple math form. The binary logit model can be expressed as follows:

$$P\left(y=1|x\right)=F\left(x,\beta\right)=\text{›}\ \left(x'\beta\right)=\frac{\exp\left(x'\beta\right)}{1+\exp\left(x'\beta\right)}$$

$$P\left(y=0|x\right)=1-F\left(x,\beta\right)=1-\text{›}\ \left(x'\beta\right)=1-\frac{\exp\left(x'\beta\right)}{1+\exp\left(x'\beta\right)}$$

$$E\left(y|x\right)=1\bullet P\left(y=1|x\right)+0\bullet P\left(y=0|x\right)=P\left(y=1|x\right) \quad (1)$$

where $F\left(x,\beta\right)$ is a link function, which connects explanatory variables and explained variables. Assuming $F\left(x,\beta\right)$ is the cumulative distribution function of the logical distribution, the log-likelihood function under independent individuals is:

$$lnL\left(\beta|y,x\right)=\sum_{i=1}^{n}y_i\ln\left[\text{›}\ \left(x_i^{'}\beta\right)\right]+\sum_{i=1}^{n}(1-y_i)\ln\left[1-\text{›}\ \left(x_i^{'}\beta\right)\right] \quad (2)$$

In our study, y is the WTU for renewable energy electricity; x is the explanatory variables, including gender, age, education level, income, the number of family members, environmental protection behavior, knowledge of renewable energy, the participation in renewable energy planning, satisfaction with the implementation effect of renewable energy policies, trust in government environmental governance, and the recognition of the high renewable energy electricity cost.

Secondly, the WTP for renewable energy electricity is divided into six categories with ordered data. Consistent with the above, this paper uses the ordered logit model.

Under our study, the variable can be observed as follows:

$$y=\begin{cases} 0, if\ y^{*}\le p_0 \\ 1, if\ p_0\le y^{*}\le p_1 \\ 2, if\ p_1\le y^{*}\le p_2 \\ 3, if\ p_2\le y^{*}\le p_3 \\ 4, if\ p_3\le y^{*}\le p_4 \\ 5, if\ p_4\le y^{*}\le p_5 \end{cases} \quad (3)$$

wWhere, the WTP for renewable energy electricity is divided into six categories, ranging from 0 to 5 in Eq. (3). p_0, p_1, p_2, p_3, p_4, and p_5 signify the breaking points. The probability of y under the accumulative distribution function of the logical distribution is:

$$
\begin{aligned}
&P\left(y=0|x\right)=P\left(y\le p_0|x\right)=P\left(x'\beta+\varepsilon\le p_0|x\right)=P\left(\varepsilon\le p_0-x'\beta|x\right)=\Phi\left(p_0-x'\beta\right)\\
&P\left(y=1|x\right)=P\left(p_0\le y\le p_1|x\right)=P\left(p_0\le x'\beta+\varepsilon\le p_1|x\right)=\Phi\left(p_1-x'\beta\right)-\Phi\left(p_0-x'\beta\right)\\
&P\left(y=2|x\right)=P\left(p_1\le y\le p_2|x\right)=P\left(p_1\le x'\beta+\varepsilon\le p_2|x\right)=\Phi\left(p_2-x'\beta\right)-\Phi\left(p_1-x'\beta\right)\\
&P\left(y=3|x\right)=P\left(p_2\le y\le p_3|x\right)=P\left(p_2\le x'\beta+\varepsilon\le p_3|x\right)=\Phi\left(p_3-x'\beta\right)-\Phi\left(p_2-x'\beta\right)\\
&P\left(y=4|x\right)=P\left(p_3\le y\le p_4|x\right)=P\left(p_3\le x'\beta+\varepsilon\le p_4|x\right)=\Phi\left(p_4-x'\beta\right)-\Phi\left(p_3-x'\beta\right)\\
&P\left(y=5|x\right)=P\left(p_4\le y\le p_5|x\right)=P\left(p_4\le x'\beta+\varepsilon\le p_5|x\right)=1-\Phi\left(p_4-x'\beta\right) \qquad (4)
\end{aligned}
$$

The log-likelihood function under independent individuals is:

$$
\begin{aligned}
&\mathrm{lnL}=\ln\left[\Phi\left(p_0-x_i'\beta\right)\right]+p_1\ln\left[\Phi\left(p_1-x_i'\beta\right)-\Phi\left(p_0-x_i'\beta\right)\right]\\
&+p_2\ln\left[\Phi\left(p_2-x_i'\beta\right)-\Phi\left(p_1-x_i'\beta\right)\right]+p_3\ln\left[\Phi\left(p_3-x_i'\beta\right)-\Phi\left(p_2-x_i'\beta\right)\right]\\
&+p_4\ln\left[\Phi\left(p_4-x_i'\beta\right)-\Phi\left(p_3-x_i'\beta\right)\right]+p_5\ln\left[1-\Phi\left(p_4-x_i'\beta\right)\right] \qquad (5)
\end{aligned}
$$

The maximum likelihood estimation method can be adapted to estimate the parameters and breaking points in Eq. (5). In our study, y is the WTP for renewable energy electricity; x is the explanatory variables, including gender, age, education level, income, the number of family members, environmental protection behavior, renewable energy knowledge, participation in renewable energy planning, satisfaction with the implementation effect of renewable energy policies, trust in government environmental governance, recognition of the high renewable energy electricity cost, WTU for renewable energy electricity, residents' preference for the payment mechanisms, and payment mechanisms residents received.

4. RESULTS AND DISCUSSION

4.1. Results Of Willingness To Pay

In this section, this paper will analyze residents' WTP for renewable energy electricity. Before this, this paper will firstly discuss residents' WTU for renewable energy power. Table 2 shows the results of WTU estimated in the logit model. In Model (1) of Table 2, the explanatory variables of the social characteristics include gender, age, education, income, and family members. The results show that males are more willing to use renewable energy than females. Older respondents are more willing to use renewable energy electricity, and respondents with higher education and income levels are also more willing to use renewable energy. In addition, respondents with fewer family members are more willing to use renewable energy power. This may be because fewer family members have less disagreement on the issue of the use of renewable energy electricity. In Model (2) of Table 2, this paper also considers the respondents' cognitions and behaviors. It can be found that if respondents have more frequent environmental protection behaviors, the more their participation in renewable energy planning, the more satisfied they are with the implementation of renewable energy policies. Also, the higher their recognition of the higher renewable energy cost, the more willing they are to use renewable energy electricity. Therefore, it is very important to strengthen residents' understanding, participation, and recognition of renewable energy. In addition to age and education, other variables of social characteristics still show significant effects.

Table 2. The results of willingness to use

	WTU	
	(1)	(2)
Gender	0.3256*** (0.1169)	0.2797** (0.1202)
Age	0.3034*** (0.0934)	0.1124 (0.0951)
Education	0.3644*** (0.1002)	0.1205 (0.1039)
Income	0.1537*** (0.0431)	0.0823* (0.0440)
Member	-0.3526*** (0.0980)	-0.3536*** (0.1000)
Behavior		0.2763*** (0.0941)
Knowledge		-0.0209 (0.0962)
Participate		0.1765** (0.0847)
Satisfaction		0.2381*** (0.0983)
Trust		0.0874 (0.0937)
Cost		0.3158*** (0.0834)
Constant	0.3835 (0.3743)	-1.6412*** (0.4336)
Log likelihood	-1140.1154	-1071.2498
Pseudo R2	0.0450	0.1027
Observation	4300	4300

Note: ***, **, and * indicate the significance at the 1% level, 5% level, and 10% level, respectively. The standard error is reported in the parentheses.

Next, this paper discusses residents' WTP for renewable energy electricity. This study found that 15.91% of the respondents were unwilling to pay for renewable energy electricity. The potential reasons concerning respondents' unwillingness to pay for renewable energy electricity are shown in Table 3. About 40.94% of the respondents thought that the cost is already paid in taxes and fees whiles 39.62% of the respondents were of the view that their family income is too low to pay such taxes and fees. Additionally, 31.58% of the respondents expected the cost to be paid by the government and thermal power enterprises. It can be seen that the main reasons why the respondents were unwilling to pay these fees were that they find it to be unreasonable, or they worry that paying such fees will increase the financial pressure on their families. This result is consistent with Hast et al. (2015) and Xie and Zhao (2018).

Table 3. Barriers to paying for renewable energy electricity

Barrier	Percentages (answers from the total sample) %
Climate and environmental issues are not prominent. Thus, there is no need to develop renewable energy power.	18.13%
Family income is too low to pay.	39.62%
Excess power supply. Thus, there is no need to develop renewable energy power.	16.81%
The cost should be paid by the government and thermal power enterprises.	31.58%
The utilization rate of renewable energy power generation is low, and the supporting equipment and operation are imperfect.	22.08%
The cost is already paid in taxes and fees.	40.94%
Not sure whether the purchased renewable energy electricity comes from renewable energy sources.	19.88%

Note: Respondents could select more than one barrier.

In our study, 3616 respondents were willing to pay for renewable energy electricity, making up about 84.09%. For example, 70.2% of respondents were willing to pay for renewable energy electricity based on the sample of Jiangsu in China in the study of Zhang and Wu (2012), and there are 67.3% of respondents willing to pay for renewable energy electricity based on the sample of Tianjin in China in the study of Xie and Zhao (2018). Compared with previous studies, the proportion of residents' WTP for renewable energy power increased. It may also be because residents in China's four first-tier cities will be more willing to pay for renewable energy power.

Table 4 presents the results of WTP for renewable energy electricity based on the ordered logit model. Model (3) in Table 4 lists the coefficients of the social characteristics, residents' cognitions and behaviors, WTU, payment preferences, and payment mechanisms received in the survey. The results show that gender, education, income level, family members, knowledge, participation, satisfaction, trust, cost, WTU, payment preference, and payment questionnaire type significantly impact their WTP. Males are willing to pay more for renewable energy electricity than females. It may be because females are thriftier than males (Connor, 2004). Respondents with higher education and income levels may receive more clean and low-carbon education and have the greater financial strength to bear the cost, so they have a strong enthusiasm to pay more for renewable energy electricity. Respondents with a fewer number of family members are less willing to pay more for renewable energy electricity. Respondents with more family members are more likely to share the cost. The above results are similar to Guo et al. (2014), Lee and Heo (2016), and Xie and Zhao (2018). Residents with more access to green information are willing to pay more for renewable energy electricity. This is consistent with Lee and Heo (2016) and Xie and Zhao (2018). Besides, respondents who are more satisfied with the implementation of renewable energy policies and have a higher degree of trust in the government's governance believe that the government can better use the funds to support the development of renewable energy. Therefore, they are also willing to pay more for renewable energy electricity.

Moreover, respondents with higher recognition of the high energy cost are also willing to pay higher fees for renewable energy electricity. Considering the WTU, this paper found that respondents willing to use renewable energy power are willing to pay more for renewable energy power. Regarding the payment mechanism, respondents who prefer the voluntary payment mechanism will pay more enthusiastically. However, respondents under the mandatory payment mechanism will give a higher WTP valuation. This result is consistent with Guo et al. (2014), and Akcura (2015).

In model (4) of Table 4, this paper estimates based on the sample of WTU, and the results are consistent with model (3) in Table 4. Similarly, in Model (5) and (6) in Table 4, this paper also estimates based on the sample of a mandatory and voluntary payment mechanism, respectively, with results that are basically in line with model (3) in Table 4. It is worth noting that in the sample for compulsory payment mechanism, the impact of respondents' payment preferences on WTP is not significant. However, in the sample of a voluntary payment mechanism, the effect of respondents' payment preferences on WTP is significant. Although respondents prefer to pay under the voluntary payment mechanism, respondents are more likely to pay more for renewable energy electricity under the mandatory payment mechanism, which is consistent with Akcura (2015).

Table 4. The results of willingness to pay

	Pooled sample	WTU sample	M sample	V sample
	Model (3)	**Model (4)**	**Model (5)**	**Model (6)**
Gender	0.2112*** (0.0610)	0.2298*** (0.0635)	0.1471* (0.0854)	0.2455*** (0.0883)
Age	0.0173 (0.0512)	-0.0174 (0.0535)	0.0793 (0.0673)	-0.0933 (0.0805)
Education	0.1679*** (0.0555)	0.17523*** (0.0584)	0.1925*** (0.0748)	0.1028 (0.0843)
Income	0.1414*** (0.0225)	0.1519*** (0.0231)	0.1573*** (0.0311)	0.1292*** (0.0328)
Member	0.3564*** (0.0519)	0.3614*** (0.0535)	0.3184*** (0.0645)	0.3827*** (0.0788)
Behavior	-0.0086 (0.0479)	0.0056 (0.0498)	-0.0107 (0.0645)	0.0160 (0.0719)
Knowledge	0.0824* (0.0471)	0.0741 (0.0487)	0.0632 (0.0611)	0.0927 (0.0742)
Participate	0.2591*** (0.0408)	0.2373*** (0.0487)	0.2567*** (0.0548)	0.2466*** (0.0617)
Satisfaction	0.1097** (0.0518)	0.1344** (0.0542)	0.0448 (0.0675)	0.1883** (0.0812)
Trust	0.1281*** (0.0499)	0.1023** (0.0520)	0.2067*** (0.0663)	0.0250 (0.0762)
Cost	0.4532*** (0.0455)	0.4905*** (0.0471)	0.4993*** (0.0605)	0.3880*** (0.0700)
WTU	0.5453*** (0.1180)	-	0.6668*** (0.1390)	0.1267 (0.2313)
Payment preference	0.2291*** (0.0861)	0.2586*** (0.0900)	0.1093 (0.1114)	0.3657*** (0.1377)
Payment questionnaire type	-0.5732*** (0.0609)	-0.6050*** (0.0626)	-	-
Cut1	3.8892*** (0.2730)	3.4411*** (0.2805)	4.0912*** (0.3373)	3.5264*** (0.4940)
Cut2	5.3640*** (0.2770)	4.8859*** (0.2837)	5.7714*** (0.3448)	4.8350*** (0.4982)
Cut3	6.5782*** (0.2831)	6.1078*** (0.2837)	6.9613*** (0.3538)	6.0796*** (0.5059)
Cut4	7.7198*** (0.2893)	7.2557*** (0.2958)	8.0714*** (0.3624)	7.2843*** (0.5142)
Cut5	8.8708*** (0.2980)	8.4330*** (0.3050)	9.1204*** (0.3730)	8.7064*** (0.5285)

Table 4 continued on next page

Table 4 continued

	Pooled sample	WTU sample	M sample	V sample
	Model (3)	Model (4)	Model (5)	Model (6)
Log likelihood	-6201.5231	-5789.5122	-3351.9849	-2824.6148
Pseudo R2	0.0731	0.0715	0.0901	0.0428
Observation	3896	3623	2119	1777

Note: ***, **, and * indicate the significance at the 1% level, 5% level, and 10% level, respectively. The standard error is reported in the parentheses.

4.2. Robustness Check

Before further discussion, this paper will conduct a robustness check. Firstly, this paper uses the probit and ordered probit models to verify Tables 2 and 4, respectively. From the results of the robustness check in Appendix Table A, it can be found that the signs and significance levels of all coefficients are almost the same as those in Tables 2 and 4. Therefore, the results obtained in the previous section should be reliable and robust.

4.3. The Marginal Effect

In Section 4.1, this paper estimates the average effects of various variables on the WTP of renewable energy electricity. However, the marginal impacts of the various variables on the WTP of renewable energy power should also receive attention. This section will take the pooled sample as an example to show the marginal impacts of the various variables on the WTP of renewable energy electricity.

Table 5. Results of marginal effect

	Pr(y=0)	Pr(y=1)	Pr(y=2)	Pr(y=3)	Pr(y=4)	Pr(y=5)
Gender	-0.0224	-0.0189	-0.0005	0.0133	0.0144	0.0141
Age	-0.0018	-0.0015	-0.0000	0.0011	0.0012	0.0012
Education	-0.0178	-0.0150	-0.0004	0.0106	0.0115	0.0112
Income	-0.0150	-0.0127	-0.0004	0.0089	0.0097	0.0095
Member	-0.0378	-0.0319	-0.0009	0.0225	0.0243	0.0238
Behavior	0.0009	0.0008	0.0002	-0.0005	-0.0006	-0.0006
Knowledge	-0.0087	-0.0074	-0.0002	0.0052	0.0056	0.0055
Participate	-0.0275	-0.0232	-0.0007	0.0164	0.0177	0.0173
Satisfaction	-0.0116	-0.0098	-0.0003	0.0069	0.0075	0.0073
Trust	-0.0136	-0.0115	-0.0003	0.0081	0.0088	0.0086
Cost	-0.0481	-0.0406	-0.0012	0.0286	0.0310	0.0303
WTU	-0.0579	-0.0489	-0.0014	0.0345	0.0372	0.0365
Payment preference	-0.0243	-0.0205	-0.0006	0.0145	0.0157	0.0153
Payment questionnaire type	0.0609	0.0514	0.0015	-0.0362	-0.0392	-0.0383

Note: The value with a bold font is significant.

Table 5 presents the results of the marginal effect. The values in columns "Pr(y=2)" are insignificant. Except for the variables "Age" and "Behavior," the values of the marginal effect of other variables are all significant. Except for the "Payment questionnaire type" variable, the signs of the other variables are all negative in columns "Pr(y=0)", "Pr(y=1)" and "Pr(y=2)", but positive in columns "Pr(y=3)", "Pr(y=4)" and "Pr(y=5)". In terms of "gender," compared with females, males are more likely to pay the highest, second-highest, and third-highest categories of WTP. Regarding the "Participate" variable, the value in columns "Pr(y=0)" is -0.0275, meaning that if the degree of participation in renewable energy planning decreases by one tier, the probability of paying for the lowest WTP decreases by 2.75%. The value in columns "Pr(y=5)" is 0.0173, meaning that if the degree of participation in renewable energy planning increases by one tier, the probability to pay for the highest WTP increases by 1.73%. For the "Payment preference" variable, the values in columns "Pr(y=0)" and "Pr(y=1)" are -0.0243 and -0.0205 respectively, indicating that compared with the respondents who prefer the voluntary payment mechanism, the respondents who prefer the compulsory payment mechanism are 2.43% and 2.05% less likely to pay for the lowest and second-lowest WTPs. However, the signs of values changed to positive beginning with column "Pr(y=3)". The value in column "Pr(y=5)" is 0.0153, indicating that compared with the respondents who prefer the compulsory payment mechanism, the respondents who prefer the voluntary payment mechanism are 1.53% more likely to pay for the highest WTP. The marginal effects of other variables have similar explanations.

4.4. Discussing The Willingness To Pay For Renewable Energy Electricity And Tradable Green Certificate

This section calculates the mean WTP under the baseline scenario, the WTU for renewable energy power scenario, the mandatory payment scenario, and the voluntary payment scenario. Under the baseline, WTU for renewable energy power, mandatory payment, and voluntary payment, the mean WTP is 44.06, 45.49, 51.77, and 34.85 yuan/month, respectively. Therefore, the mean WTPs ranges from US$ 5.09-7.56 per month. Also, as shown in Table 6, this paper compares the mean WTP calculated in our study with other results in the previous literature. With the development of the economy and renewable energy in recent years, the overall income level and acceptance of renewable energy power for residents have relatively increased. Besides, the samples investigated in this paper come from four first-tier cities in China. Therefore, the residents' WTP will also be higher than that in other cities. Compared with the results in the previous literature, it can be seen that the estimated results in this paper are reasonable.

Table 6. Summary of studies on the WTP for renewable energy electricity

Reference	Country	Method	Year	WTP
Zhang and Wu (2012)	Jiangsu, China	CV-PC	2009	US$ 1.15-1.51 per month
Pallab et al. (2011)	New Mexico, USA	CV-OE	2010	US$ 5.77-15.04 per month
Guo et al. (2014)	Beijing, China	CV-SBDC	2010	US$ 2.7-3.3 per month
Mozumder et al. (2011)	USA	CV-OE	2010	US$ 5.77 per month (10%); US$ 15.04 per month (20%)
Chan et al. (2015)	South African	CV-DC; CV-OE	2013	US$ 3.75 per month (DC); US$ 13.75 per month (OE)
Lee and Heo (2016)	South Korea	CV-DBDC	2014	US$ 3.10 per month
Xie and Zhao (2018)	Tianjin, China	CV-OE	2016	US$ 4.76 per month

Table 6 continued on next page

Table 6 continued

Reference	Country	Method	Year	WTP
This study	Beijing, Shanghai, Guangzhou, and Shenzhen, China	CV-PC	2019	US$ 5.09-7.56 per month

Based on the mean WTP (34.85 yuan/month) under the voluntary payment scenario, the residents will voluntarily pay 418.20 yuan for renewable energy power a year. In China, it is indistinguishable whether the electricity received by residents is generated through traditional or renewable energy. Therefore, residents cannot directly purchase electricity from renewable energy sources. Residents who want to buy renewable energy power can go to the China Green Power Certificate Subscription Trading Platform to purchase voluntarily, which signifies proof of the consumption of renewable energy power. According to the data from the China Green Power Certificate Subscription Trading Platform, from July 1, 2017, to June 18, 2020, the transaction prices of green power certificates for wind power ranged from 128.6-330 yuan/piece, with an average price of 175.1 yuan/piece. The transaction prices of green power certificates for photovoltaic power ranged from 518.7-900 yuan/piece, with an average price of 668.1 yuan/piece. Therefore, residents are expected to be able to purchase approximately 1-3 wind power green certificates a year, as there is still pressure to purchase photovoltaic green certificates. In fact, as of June 18, 2020, the green power certificate subscription has been trialed for nearly three years. 2177 users were participating in the China Green Power Certificate Subscription Platform to purchase green power certificates, and a total of 37,816 green power certificates were subscribed. Among them, the vast majority of green power certificates were purchased by companies, as the number of residents purchasing green power certificates on China's green certificate subscription platform was relatively small. Moreover, these individuals were concerned about the energy industry and regarded the purchasing behavior of green power certificates as a form of "self-realization." There is a big gap between residents' actual green power purchase behavior and expected WTP. Chinese residents have insufficient motivations to participate in renewable energy electricity consumption.

It has been found in many previous studies that the respondents' self-reported attitude towards environmental protection does not guarantee actual environmental behavior. For example, this "attitude-behavior gap" has been observed in the related issues within the scope of the environment, energy conservation, green price planning, or corporate social responsibility (Boulstridge and Carrigan, 2000; Gadenne et al., 2011; Hartmann and Apaolaza-Ibáñez, 2012; Moraes et al., 2012; Joshi and Rahman, 2015; Knapp et al., 2020). Byrnes et al. (1995) found that only 12% and 15% of residents paid when they got the opportunity. Bird and Brown (2005) also found that only 1% of residents paid green tariffs in the UK. Akcura (2015) indicated that the actual participation rate of Finnish residents in green power purchases was very low, and the stated WTP was significantly different from the actual WTP. Knapp et al. (2020) proved that it was impossible to determine that residents with higher WTP were more likely to participate in green power purchases.

What are the reasons for the "attitude-behavior gap"? First, in the survey, there may be bias when respondents state their preferences, which may lead to an overestimation of WTP (Akcura, 2015). Nevertheless, this phenomenon is also inevitable in the survey of this paper. Second, for the voluntary payment mechanism, the "participation expectation" plays an important role (Guo et al., 2014; Akcura, 2015). In other words, if respondents know other respondents participate in purchasing green electricity, they may be encouraged to participate. Therefore, if there is no basis for a certain number of participants, it is difficult to improve the actual behaviors of residents. Third, the respondents may lack trust in green power products and power companies (Salmela and Varho, 2006), which may also lead to a gap between the stated WTP and the actual WTP. Some residents may be willing to pay for renewable energy electricity, but still doubt whether their money will be used to increase the proportion of renewable energy at the same time (Knapp et al., 2020). Residents suffer from information gaps due to poor sales of renewable energy electricity products provided by suppliers and opaque details of the use of funds by suppliers. Therefore, residents need many external information and incentives to become active participants. Finally, the imperfection of the voluntary subscription mechanism for green power certificates is also one of the main reasons. As mentioned above, residents purchase green power certificates mainly for "self-realization." However, the green power certificates can be sold once, weakening their transaction attributes. Moreover, compared with the average prices of international green power certificates, the prices of green power certificates in China are 10 times higher, which also hinders the enthusiasm of residents to participate. Currently, green power certificates are not well traded in areas with relatively developed economies or relatively abundant energy (Song et al., 2020). If the problem of cross-regional transmission and local consumption of renewable energy cannot be solved, it will be difficult for residents to increase their enthusiasm for participation. In addition, the transaction objectives and rules for the voluntary subscription of green power certificates are still unclear, especially the lack of design and introduction of responsibilities and obligations for residents, which may result in insufficient subscription willingness. In China, this kind of voluntary subscription method that relies on residents' awareness is limited in stimulating them to pay for renewable energy electricity.

5. CONCLUSION AND POLICY SUGGESTIONS

This study found the following conclusions: (1) The respondents are unwilling to pay because they think they should not pay as they worry about the pressure of their household financial expenditure. (2) Respondents with more green information are willing to pay more for renewable energy electricity. Respondents who participated in renewable energy planning were more satisfied with the implementation of renewable energy policies and had a higher recognition of the high cost of renewable energy, were willing to use renewable energy, and were willing to pay more for renewable energy electricity. (3) Although respondents prefer to pay under the voluntary payment mechanism, they are more likely to pay more for renewable energy electricity under the mandatory payment mechanism. The mean WTP under the mandatory payment mechanism is 51.77 yuan/month, while the mean WTP under the voluntary payment mechanism is 34.85 yuan/month. (4) The huge cost problem behind the compulsory payment mechanism and residents' preference for voluntary payment mechanisms make the government prioritize trying voluntary payment mechanisms for residents. The increased participation of residents in the voluntary subscription of green power certificates may play an important role in achieving international and national climate goals. However, China's current voluntary subscription mechanism for green power certification and its supporting policies and transaction environment is imperfect. They are not sufficiently attractive to residents, resulting in a large gap between residents' actual purchase behavior and expected WTP.

Based on the above analysis, this paper gives targeted suggestions.

Firstly, China's voluntary subscription mechanism for green power certificates and its supporting policies and trading environment is imperfect, which results in a large gap between residents' actual green power purchase behavior and expected WTP. Enterprises that sell green power certificates should disclose the sales of renewable energy and the details of the use of funds, which is a conducive incentive for residents to participate under transparent information. The government needs to strengthen the publicity of the green power certificate mechanism and improve the relevant policies of the green power certificate mechanism. The government should not only honor residents who actively pay for renewable energy electricity but should also consider the implementation of incentive policies, such as tax reductions or discounts on electricity charges, reducing the pressure on household financial expenditure caused by paying for renewable energy power. Although it is very important to clarify the corporate responsibilities of the power grid, coal-fired power, and high-energy-consuming companies in implementing renewable energy consumption indicators as the proportion of residents' electricity consumption continues to increase, it is equally important to clarify the responsibilities and obligations of residents. The grid company can reflect the non-hydro renewable energy ratio of the grid company in the residential electricity bill so that residents can understand the source of household electricity to a certain extent and clarify their sense of responsibility. It will also help to encourage residents' willingness to pay and behavior.

In addition, to promote the residents' WTU for renewable energy power and pay more for renewable energy power, residents' access to green information needs to be broadened to make residents understand renewable energy better and participate in planning. At the same time, the Chinese government should gain residents' satisfaction and trust in implementing renewable energy policies and government governance. Moreover, the residents currently participating in the green power certificate subscription are individuals who are concerned about the renewable energy industry. Efforts in the above aspects will help stimulate residents' actual behavior.

Finally, though the WTP under the mandatory payment mechanism is higher than the WTP under the voluntary payment mechanism, the voluntary payment mechanism is preferred by the residents. However, the user participation rate in voluntary green marketing activities is extremely low, mainly due to the issue of self-realization (Ryan, 2007; Akcura, 2015). It is only by encouraging a wider range of residents to participate and forming a scale effect can the voluntary mechanism play a better role. In the future, voluntary and mandatory payment mechanisms can be combined to complement each other. No matter which payment mechanism is adopted, the corresponding supporting policies must be discussed in depth.

ACKNOWLEDGMENT

This paper is supported by National Natural Science Foundation of China (Key Program,No 72133003)

REFERENCES

Akcura, E. (2015). Mandatory versus voluntary payment for green electricity. *Ecological Economics*, *116*, 84–94. doi:10.1016/j.ecolecon.2015.02.027

Arega, T., & Tadesse, T. (2017). Household willingness to pay for green electricity in urban and peri-urban Tigray, northern Ethiopia: Determinants and welfare effects. *Energy Policy*, *100*, 292–300. doi:10.1016/j.enpol.2016.10.022

Bateman, I., Langford, I., Turner, R., Willis, K., & Garrod, G. (1995). Elicitation and truncation effects in contingent valuation. *Ecological Economics*, *12*(2), 161–179. doi:10.1016/0921-8009(94)00044-V

Bird, L., & Brown, E. (2005). *Trends in Utility Pricing Programs. Tech. rep*. National Renewable Energy Laboratory.

Boulstridge, E., & Carrigan, M. (2000). Do consumers really care about corporate responsibility? Highlighting the consumer attitude-behaviour gap. *Journal of Communication Management (London)*, *4*(4), 355–368. doi:10.1108/eb023532

Bui, T. D., & Tseng, M. L. (2022). A Data-Driven Analysis on Sustainable Energy Security: Challenges and Opportunities in World Regions. *Journal of Global Information Management*, *30*, 38.

Chan, K. Y., Oerlemans, L. A. G., & Volschenk, J. (2015). On the construct validity measures of willingness to pay for green electricity: Evidence from a South African case. *Applied Energy*, *160*, 321–328. doi:10.1016/j.apenergy.2015.09.068

Chen, Y. F., & Lin, B. Q. (2020a). Slow diffusion of renewable energy technologies in China: An empirical analysis from the perspective of innovation system. *Journal of Cleaner Production*, *261*, 121186. doi:10.1016/j.jclepro.2020.121186

Chen, Y. F., & Lin, B. Q. (2020b). Decomposition analysis of patenting in renewable energy technologies: From an extended LMDI approach perspective based on three Five-Year Plan periods in China. *Journal of Cleaner Production*, *269*, 122402. doi:10.1016/j.jclepro.2020.122402

Connor, R. E. W. (2004). *Accounting and Narrative: Keeping Books in Eighteenth-Century England*. Routledge. doi:10.4324/9780203646038

Du, Z. L., & Lin, B. Q. (2017). How oil price changes affect car use and purchase decisions? Survey evidence from Chinese cities. *Energy Policy*, *111*, 68–74. doi:10.1016/j.enpol.2017.09.017

Dubey, S., Salwan, P., & Agarwal, N. K. (2022). Application of Machine Learning Algorithm in Managing Deviant Consumer Behaviors and Enhancing Public Service. *Journal of Global Information Management*, 30.

Echaniz, E., Ho, C. Q., Rodriguez, A., & dell'Olio, L. (2019). Comparing best-worst and ordered logit approaches for user satisfaction in transit services. *Transportation Research Part A, Policy and Practice*, *130*, 752–769. doi:10.1016/j.tra.2019.10.012

Gadenne, D., Sharma, B., Kerr, D., & Smith, T. (2011). The influence of consumers' environmental beliefs and attitudes on energy saving behaviours. *Energy Policy*, *39*(12), 7684–7694. doi:10.1016/j.enpol.2011.09.002

Guo, X. R., Liu, H. F., Mao, X. Q., Jin, J. J., Chen, D. S., & Cheng, S. Y. (2014). Willingness to pay for renewable electricity: A contingent valuation study in Beijing, China. *Energy Policy*, *68*, 340–347. doi:10.1016/j.enpol.2013.11.032

Hartmann, P., & Apaolaza Ibanez, V. (2007). Managing customer loyalty in liberalized residential energy markets: The impact of energy branding. *Energy Policy*, *35*(4), 2661–2672. doi:10.1016/j.enpol.2006.09.016

Hartmann, P., & Apaolaza-Ibáñez, V. (2012). Consumer attitude and purchase intention toward green energy brands: The roles of psychological benefits and environmental concern. *Journal of Business Research*, *65*(9), 1254–1263. doi:10.1016/j.jbusres.2011.11.001

Hassen, S. (2018). The effect of farmyard manure on the continued and discontinued use of inorganic fertilizer in Ethiopia: An ordered probit analysis. *Land Use Policy*, *72*, 523–532. doi:10.1016/j.landusepol.2018.01.002

Hast, A., & Syri, A. S. (2015). Consumer attitudes towards renewable energy in China—The case of Shanghai. *Sustainable Cities and Society*, *17*, 69–79. doi:10.1016/j.scs.2015.04.003

Huijts, N. M. A., Molin, E. J. E., & Van Wee, B. (2014). Hydrogen fuel station acceptance: A structural equation model based on the technology acceptance framework. *Journal of Environmental Psychology*, *38*, 153–166. doi:10.1016/j.jenvp.2014.01.008

Joshi, Y., & Rahman, Z. (2015). Factors affecting green purchase behaviour and future research directions. *International Strategic Management Review*, *3*(1), 128–143. doi:10.1016/j.ism.2015.04.001

Kardooni, R., Yusoff, S. B., & Kari, F. B. (2016). Renewable energy technology acceptance in Peninsular Malaysia. *Energy Policy*, *88*, 1–10. doi:10.1016/j.enpol.2015.10.005

Kardooni, R., Yusoff, S. B., Kari, F. B., & Moeenizadeh, L. (2018, February). Public opinion on renewable energy technologies and climate change in Peninsular Malaysia. *Renewable Energy*, *116*, 659–668. doi:10.1016/j.renene.2017.09.073

Kato, T., & Hidano, N. (2002). *An empirical comparison between tax payment and donation in a contingent valuation survey: value of preserving the Satsunai River, Japan*. Discussion Paper No. 02-04, Department of Social Engineering, Tokyo Institute of Technology.

Knapp, L., O'Shaughnessy, E., Heeter, J., Mills, S., & DeCicco, J. M. (2020). Will consumers really pay for green electricity? Comparing stated and revealed preferences for residential programs in the United States. *Energy Research & Social Science*, *65*, 101457. doi:10.1016/j.erss.2020.101457

Koto, P. S., & Yiridoe, E. K. (2019). Expected willingness to pay for wind energy in Atlantic Canada. *Energy Policy*, *129*, 80–88. doi:10.1016/j.enpol.2019.02.009

Lee, C.-Y., & Heo, H. (2016). Estimating willingness to pay for renewable energy in South Korea using the contingent valuation method. *Energy Policy*, *94*, 150–156. doi:10.1016/j.enpol.2016.03.051

LinB.ChenY. (2020). *Rethinking willingness to pay for renewable energy electricity in China*. http://www.energy-proceedings.org/wp-content/uploads/enerarxiv/1603269177.pdf

Lin, B. Q., & Chen, Y. F. (2018). Carbon price in China: A CO2 abatement cost of wind power perspective. *Emerging Markets Finance & Trade*, *54*(07), 1653–1671. doi:10.1080/1540496X.2017.1386547

Lin, B. Q., & Chen, Y. F. (2019a). Does electricity price matter for innovation in renewable energy technologies in China? *Energy Economics*, *78*, 259–266. doi:10.1016/j.eneco.2018.11.014

Lin, B. Q., & Chen, Y. F. (2019b). Impacts of policies on innovation in wind power technologies in China. *Applied Energy*, *247*, 682–691. doi:10.1016/j.apenergy.2019.04.044

Lin, B. Q., & Tan, R. P. (2017). Estimation of the environmental values of electric vehicles in Chinese cities. *Energy Policy*, *104*, 221–229. doi:10.1016/j.enpol.2017.01.037

Lin, B. Q., & Wu, W. (2018). Why people want to buy electric vehicle: An empirical study in first-tier cities of China. *Energy Policy*, *112*, 233–241. doi:10.1016/j.enpol.2017.10.026

Moraes, C., Carrigan, M., & Szmigin, I. (2012). The coherence of inconsistencies: Attitude–behaviour gaps and new consumption communities. *Journal of Marketing Management*, *28*(1/2), 103–128. doi:10.1080/0267257X.2011.615482

Mozumder, P., Vásquez, W. F., & Marathe, A. (2011). Consumers' preference for renewable energy in the southwest USA. *Energy Economics*, *33*(6), 1119–1126. doi:10.1016/j.eneco.2011.08.003

Ngan, T. T., Do, V. V., Huang, J. D., Redmon, P. B., & Minh, H. V. (2019). Willingness to use and pay for smoking cessation service via text-messaging among Vietnamese adult smokers, 2017. *Journal of Substance Abuse Treatment*, *104*, 1–6. doi:10.1016/j.jsat.2019.05.014 PMID:31370973

Oerlemans, L. A. G., Chan, K. Y., & Volschenk, J. (2016). Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. *Renewable & Sustainable Energy Reviews*, *66*, 875–885. doi:10.1016/j.rser.2016.08.054

Ouyang, X. L., Wang, W. X., & Sun, C. W. (2019). Haze, health, and income: An integrated model for willingness to pay for haze mitigation in Shanghai, China. *Energy Economics*, *84*, 104535. doi:10.1016/j.eneco.2019.104535

Pallab, M., Vásquez, W. F., & Achla, M. (2011). Consumers' preference for renewable energy in the southwest USA. *Energy Economics, 33*(6), 1119-1126.

Ramos, A., & Rouboa, A. (2020). Renewable energy from solid waste: Life cycle analysis and social welfare. *Environmental Impact Assessment Review*, *85*, 106469. doi:10.1016/j.eiar.2020.106469 PMID:32952252

Reddy, S., & Painuly, J. P. (2004). Diffusion of renewable energy technologies—Barriers and stakeholders' perspectives. *Renewable Energy*, *29*(9), 1431–1447. doi:10.1016/j.renene.2003.12.003

Salmela, S., & Varho, V. (2006). Consumers in the green electricity market in Finland. *Energy Policy*, *34*(18), 3669–3683. doi:10.1016/j.enpol.2005.08.008

Song, X. H., Han, J. J., Shan, Y. Q., Zhao, C. P., Liu, J. P., & Kou, Y. (2020). Efficiency of tradable green certificate markets in China. *Journal of Cleaner Production*, *264*, 121518. doi:10.1016/j.jclepro.2020.121518

Sundt, S., & Rehdanz, K. (2015). Consumers' willingness to pay for green electricity: A meta-analysis of the literature. *Energy Economics*, *51*, 1–8. doi:10.1016/j.eneco.2015.06.005

Tan, R. P., & Lin, B. Q. (2020). Are people willing to support the construction of charging facilities in China? *Energy Policy*, *143*, 111604. doi:10.1016/j.enpol.2020.111604

Viklund, M. (2004). Energy policy options—From the perspective of public attitudes and risk perceptions. *Energy Policy*, *32*(10), 1159–1171. doi:10.1016/S0301-4215(03)00079-X

Wiser, R. H. (2007). Using contingent valuation to explore willingness to pay for renewable energy: A comparison of collective and voluntary payment vehicles. *Ecological Economics*, *62*(3-4), 419–432. doi:10.1016/j.ecolecon.2006.07.003

Wüstenhage, R., Wolsink, M., & Bürer, M. J. (2007). Social acceptance of renewable energy innovation:An introduction to the concept. *Energy Policy*, *35*(5), 2683–2691. doi:10.1016/j.enpol.2006.12.001

Xie, C. B., & Zhao, W. (2018). Willingness to pay for green electricity in Tianjin, China: Based on the contingent valuation method. *Energy Policy*, *114*, 98–107. doi:10.1016/j.enpol.2017.11.067

Xu, M. M., & Lin, B. Q. (2020). Exploring the "not in my backyard" effect in the construction of waste incineration power plants - based on a survey in metropolises of China. *Environmental Impact Assessment Review*, *82*, 106377. doi:10.1016/j.eiar.2020.106377

Yang, Y., Zhang, H., Xiong, W., Zhang, D., & Zhang, X. (2018). Regional power system modeling for evaluating renewable energy development and CO2 emissions reduction in China. *Environmental Impact Assessment Review*, *73*, 142–151. doi:10.1016/j.eiar.2018.08.006

Zhang, L., & Wu, Y. (2012). Market segmentation and willingness to pay for green electricity among urban residents in China: The case of Jiangsu Province. *Energy Policy*, *51*, 514–523. doi:10.1016/j.enpol.2012.08.053

Zhao, X. G., Zhou, Y., Zuo, Y., Meng, J., & Zhang, Y. Z. (2019). Research on optimal benchmark price of tradable green certificate based on system dynamics: A China perspective. *Journal of Cleaner Production*, *230*, 241–252. doi:10.1016/j.jclepro.2019.04.408

Zhou, Y., Chen, H. B., Xu, S. D., & Wu, L. B. (2018). How cognitive bias and information disclosure affect the willingness of urban residents to pay for green power. *Journal of Cleaner Production*, *189*, 552–562. doi:10.1016/j.jclepro.2018.03.222

APPENDIX A

Table 7. The results of the robustness check

	Whether to WTU	Pooled sample	WTU sample	M sample	V sample
Gender	0.1309** (0.0613)	0.1249*** (0.0356)	0.1358*** (0.0370)	0.0922* (0.0500)	0.1416*** (0.0514)
Age	0.0610 (0.0484)	0.0018 (0.0294)	-0.0175 (0.0307)	0.0296 (0.0385)	-0.0556 (0.0466)
Education	0.0609 (0.0527)	0.0852*** (0.0320)	0.0884*** (0.0337)	0.0988** (0.0430)	0.0512 (0.0488)
Income	0.0442** (0.0225)	0.0746*** (0.0129)	0.0815*** (0.0132)	0.0797*** (0.0179)	0.0700*** (0.0187)
Member	-0.1978*** (0.0514)	0.2044*** (0.0299)	0.2123*** (0.0309)	0.1874*** (0.0398)	0.2184*** (0.0456)
Behavior	0.1349*** (0.0477)	-0.0041 (0.0277)	0.0023 (0.0288)	-0.0192 (0.0372)	0.0252 (0.0418)
Knowledge	-0.0175 (0.0487)	0.0582** (0.0274)	0.0503* (0.0283)	0.0521 (0.0355)	0.0623 (0.0433)
Participate	0.0944** (0.0418)	0.1416*** (0.0234)	0.1303*** (0.0243)	0.1477*** (0.0314)	0.1273*** (0.0353)
Satisfaction	0.1270** (0.0501)	0.0611** (0.0299)	0.0765** (0.0311)	0.0183 (0.0387)	0.1192** (0.0476)
Trust	0.0456 (0.0479)	0.0813*** (0.0286)	0.0708** (0.0297)	0.1285*** (0.0377)	0.0138 (0.0444)
Cost	0.1630*** (0.0427)	0.2611*** (0.02587)	0.2831*** (0.0267)	0.2895*** (0.0342)	0.2203*** (0.0401)
WTU		0.2961*** (0.0689)	-	0.3585*** (0.0802)	0.0642 (0.1376)
Payment preference		0.1159** (0.0494)	0.1327*** (0.0516)	0.0646 (0.0638)	0.1635** (0.0794)
Payment questionnaire type		-0.3454*** (0.0353)	-0.3615*** (0.0363)	-	-
Constant	-0.6799*** (0.2269)				
Cut1		2.1337*** (0.1556)	1.9133*** (0.1615)	2.2471*** (0.1893)	1.964*** (0.2882)
Cut2		2.9851*** (0.1571)	2.7467*** (0.1628)	3.1917*** (0.1922)	2.7344*** (0.2898)
Cut3		3.7168*** (0.1594)	3.4845*** (0.1649)	3.9008*** (0.1955)	3.4921*** (0.2927)
Cut4		4.3883*** (0.1618)	4.1627*** (0.1674)	4.5588*** (0.1989)	4.1866*** (0.2960)
Cut5		5.0176*** (0.1652)	4.8104*** (0.1710)	5.1446*** (0.2031)	4.9145*** (0.3014)

Table 7 continued on next page

Table 7 continued

	Whether to WTU	Pooled sample	WTU sample	M sample	V sample
Log likelihood	-1070.3511	-6200.1318	-5782.8939	-3358.1321	-2823.4205
Pseudo R2	0.1034	0.0733	0.0726	0.0885	0.0432
Observation	4300	3896	3623	2119	1777

Note: ***, ** and * indicate the significance at the 1% level, 5% level and 10% level, respectively. The standard error is reported in the parentheses.