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Willingness to pay for renewable electricity: A contingent valuation study in Beijing, China

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HIGHLIGHTS

- Most (54%) of respondents in Beijing have positive WTP to renewable electricity.
- The average WTP for renewable electricity ranges from 2.7 to 3.3 US$ monthly.
- The main factors affecting the WTP include income, electricity consumption, bid and payment vehicle.
- Deployment of renewable electricity can cause considerable benefit.

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ABSTRACT

In China, renewable/green electricity, which can provide significant environmental benefits in addition to meeting energy demand, has more non-use value than use-value for electricity consumers, because its users have no way to actually own this use-value. To assess the value of renewable electricity and obtain information on consumer preferences, this study estimated the willingness to pay (WTP) of Beijing residents for renewable electricity by employing the contingent valuation method (CVM) and identified the factors which affect their WTP. The survey randomly selected 700 participants, of which 571 questionnaires were valid. Half of respondents were found to have positive WTP for renewable electricity. The average WTP of Beijing residents for renewable electricity is estimated to be 2.7–3.3 US$ (18.5–22.5CNY) per month. The main factors affecting the WTP of the respondents included income, electricity consumption, bid and payment vehicle. Knowledge of and a positive attitude towards renewable energy also resulted in the relatively higher willingness of a respondent to pay for renewable electricity. The proportion of respondents replying "yes" to WTP questions using a mandatory payment vehicle was slightly higher than that for questions using a voluntary vehicle. Lastly, several policy implications of this study are presented.

1. Introduction

The Chinese power industry has the largest and fastest-growing carbon emission rate among all of the country's economic sectors, as it consumes a large quantity of fossil fuels every year. Power generation is dominated by the burning of coal, which is responsible for resource depletion, significant environmental impacts and climate change. Therefore, there is an urgent need to develop renewable sources of power generation. Renewable electricity, also termed green electricity, is generated from renewable energy sources such as solar power, wind power, small-scale hydroelectric power, tidal power, and biomass power. Green electricity has significant environmental benefits and can reduce greenhouse gas emissions while meeting energy needs and decreasing dependence on fossil fuels. Therefore, the Chinese government has begun to promote the development of renewable energy, especially green electricity. For example, the Chinese Renewable Energy Law was issued in 2006 and revised in 2010, and national medium- and long-term Renewable Energy Development Plans were announced in 2007. Local governments are also actively increasing their use of renewable energy.

However, a number of barriers to the development of renewable energy in the Chinese power sector still exist. The most important of these obstacles are the price barrier and the lack

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of available capital. According to Zhao and Huang (2009) paper, the cost of power generation from wind energy is approximately 1.5–2 times that of coal-fired generation, while the cost of solar photovoltaic power ranges from 3 to 6 times that of the conventional method. Conventional subsidies cannot meet the requirements for these huge investments. To promote the deployment of renewable electricity, the government should take visible action to compensate producers for higher costs and ask consumers about their preferences. However, many questions must be answered before policies are formulated. Are household consumers willing to pay a surcharge to support renewable electricity beyond national and local government subsidies? What are consumers willing to pay? Which factors will affect the willingness to pay (WTP) of these consumers? The answers to these questions will be useful to policy makers as they develop the subsidies for renewable energy used in electricity generation.

Many studies have attempted to determine consumers' WTP for renewable energy by applying a contingent valuation method (CVM), which is one of the most popular methods used by environmental and resource economists to value environmental goods. For example, Champ and Bishop (2001) estimated the benefits of a voluntary wind energy program from the Madison Gas and Electric Company. Poe et al. (2002) and Vossler et al. (2003) estimated the voluntary willingness to pay for a renewable energy facility operated by the Niagara Mohawk Power Corporation in New York. Hite et al. (2008) investigated Alabama consumers' WTP for green energy and concluded that the consumers of the region were unaware of the potential for alternative energy. Efforts to promote the sales of green energy were therefore deemed inadequate in that study, given the widespread lack of knowledge about current programs. Whitehead and Cherry (2007) estimated the benefits of a Green Energy program in North Carolina by employing both ex-ante and ex-post approaches to mitigate or eliminate the overstatement of hypothetical willingness to pay. Zografakis et al. (2010) evaluated the citizens' public acceptance and willingness to pay for renewable energy sources in Crete, Greece, using a CV survey in a double bound dichotomous choice format.

A number of studies have focused on the valuation of specific renewable energy types. For example, Solomon and Johnson (2009) used a multi-part, split-sample contingent valuation method (CVM) and fair share (FS) survey to understand the public's valuation of mitigating global climate change through its willingness to pay for biomass or “cellulosic” ethanol. For green electricity, Nomura and Akai (2004) conducted a CVM study to estimate Japanese consumers' willingness to pay for electricity generated from renewable energy systems via a mail survey. Yoo and Kwak (2009) applied the CV method to obtain a preliminary evaluation of the benefits from the introduction of a policy that raises the percentage of green electricity consumption from 0.2% to 7% of the total electricity supply in Korea by 2011. Kim et al. (2012) analyzed the willingness of Korean households to pay more for electricity generated by either wind, photovoltaic (PV) cells, or hydropower through the contingent valuation method (CV). However, few similar studies on the WTP for green electricity or renewable energy have been conducted in China. Liu et al. (2013) examined the rural social acceptance of renewable energy deployment, using Shandong Province as a case study, via a field questionnaire survey, but the WTP value for the rural residents was not estimated. Zhang and Wu (2012) studied the energy market segmentation and estimated urban residents' WTP for green electricity in Jiangsu Province, China. To shed light on the characteristics of population segments with differing WTP amounts, these authors employed the payment card (PC) technique in their questionnaire. The results of this study estimated an average WTP range of 1.15–1.51 US$/month for urban residents in Jiangsu Province.

Although renewable electricity has the same use value as thermal power, it has more non-use value than use value for Chinese users (Zhang and Wu, 2012). First, consumers are not allowed to choose their electricity supplier, as all of their power demands are satisfied by a uniform national grid that cannot distinguish between the different types of energy. Therefore, consumers have no way to own the use-value of green electricity, even if they are willing to pay for it. Second, the key factor that drives consumers to buy green electricity in the above situation is its environmental benefit.

Electricity in Beijing is mainly provided from outside sources, with only one third produced domestically. Domestic power production is dominated by coal-fired generation, with minor contributions from other sources, including natural gas, hydro and biomass energy. Renewable electricity consumption amounted to only 3% of the city's total power use in 2010. The 12th Five-Plan set the target of renewable energy use in Beijing at 6% of the total energy consumption by the end of 2015. The main barrier to achieving this target is the relatively high cost of renewable energy generation. Renewable electricity is generally more costly than conventional coal-fired power. In addition, the time of return on capital for renewable energy development is longer than that of conventional energy, and financing for renewable energy projects is difficult. The investments required for renewable energy are huge and cannot be met by conventional subsidies. The present study attempted to estimate the WTP of Beijing residents for renewable/green electricity and identify the factors affecting their willingness to pay, particularly the impact of different payment vehicles and the “participation effect”. By applying the CV method in a new study region, we hoped to provide important information to renewable energy policy makers.

This study proceeds as follows: Section 2 introduces the methods used in this study, including the questionnaire design, payment vehicles, sampling, estimation technique, and bias control. The results and discussion of the empirical research are presented in Section 3. In the last section of this study, the main conclusions are summarized, and the policy implications of the work are presented.

2. Methodology

In the present study, we employed a single-bounded dichotomous choice format to examine the respondents' willingness to pay for renewable electricity in Beijing, China. After the DC approach was first employed by Bishop and Heberlein (1979) to measure the economic value of goose hunting, it has been the most popular method for CV studies. Respondents in the DC approach are asked to accept or reject a suggested price under a hypothetical market situation, needing only to answer ‘yes’ or ‘no’ when presented with a price. It is easier for respondents to answer DC questions than open-ended questions because respondents are familiar with discrete choices in market transactions (Hanemann, 1994). The DC format is therefore generally considered to be a superior elicitation method (Lee and Mjelde, 2007).

2.1. Survey design

This study used a face-to-face interview which has been shown to be the most reliable approach in CV studies. The survey members can explain clearly what the respondents were ask to pay for and what the individuals can benefit from the assumed non-market good by the direct interview.

The survey questionnaire was carefully designed to provide the respondents with adequate and accurate information.