energies

MDPI

Article

South Korean Household's Willingness to Pay for Replacing Coal with Natural Gas? A View from CO_2 Emissions Reduction

Seul-Ye Lim, Hyo-Jin Kim and Seung-Hoon Yoo *

Department of Energy Policy, Graduate School of Energy & Environment, Seoul National University of Science & Technology, 232 Gongreung-Ro, Nowon-Gu, Seoul 01811, Korea; sylim@seoultech.ac.kr (S.-Y.L.); hjinkim@seoultech.ac.kr (H.-J.K.)

* Correspondence: shyoo@seoultech.ac.kr; Tel.: +82-2-970-6802

Received: 30 September 2017; Accepted: 24 November 2017; Published: 2 December 2017

Abstract: Coal is currently a major electric power generation source in South Korea when considering that forty-three percent of electricity that was generated during the first quarter of 2017 came from coal. The amount of CO_2 emissions from coal-fired power plant is two times larger than that from natural gas (NG)-fired power plant in the country. In this regard, the Korean government is trying to replace some amount of coal that is used for generation with NG to reduce CO_2 emissions. However, the cost of NG-fired generation is about 1.25 times higher than that of coal-fired generation. Thus, the policy-makers demand information about the household willingness to pay (WTP) for the replacement to mitigate CO_2 emissions. This paper applies the contingent valuation (CV) approach, and assesses the household's WTP for replacing one kWh of coal-fired power with that of NG-fired power. For this purpose, a total of 1000 South Korean households were involved in the CV survey employing a dichotomous choice question. In addition to the current electricity price, KRW 121.52 (USD 0.11) per kWh, the respondents were willing to pay KRW 25.35 (USD 0.02) per kWh. The costs of NG-fired and coal-fired generation are KRW 100.13 and 78.05, respectively, per kWh. The difference between the two is KRW 22.08 per kWh, which is smaller than the mean additional WTP (KRW 25.35 per kWh). The household's additional WTP is bigger than the actual additional cost. It is concluded that the switch of power generation source from coal to NG to reduce CO_2 emissions can be supported by South Korean households.

Keywords: coal; natural gas; generation source; CO_2 emissions; contingent valuation; willingness to pay

1. Introduction

The topic of carbon dioxide (CO_2) emissions has been continuously discussed for a number of years, and the electric power sector was among the largest producers of CO_2 as a byproduct of power generation. South Korea was ranked as the eighth largest emitter of CO_2 in 2014 [1]. At the Paris Climate Change Conference in December 2015, South Korea pledged to mitigate 37% of its CO_2 emissions by 2030 [2]. Of this reduction target, 25.7% applies to the reduction of CO_2 emissions in the country, and 11.3% depends on international CO_2 emissions trading systems. According to data from the International Energy Agency [3], CO_2 emissions from the electric and heat power sector have been account for 45.51% in 2014.

The most significant electric power source in South Korea is coal [4]. For instance, forty-three percent of electricity generated during the first quarter of 2017 came from coal. Natural gas (NG) accounted for about twenty percent of electricity generation. NG-fired power plant can be made as an attractive alternative to coal-fired power plant in terms of meeting the CO_2 mitigation target. When the same amount of electricity from coal and NG is produced, the amount of CO_2 emissions from coal-fired power plant is two times larger than that from NG-fired power plant in the country.

In this regard, the South Korean government is trying to replace some amount of coal used for generation with NG to reduce CO_2 emissions. The switch of the generation source from coal to NG and renewables can drive the abatement in CO_2 emissions. On the other hand, fuel sources for electrical power generation have been influenced by economic load dispatch in South Korea. If there is no stop for the maintenance or repair, coal-fired power plants, as well as nuclear power plants, usually run 24-hour-a-day. Because NG is more expensive than coal, it is difficult to run NG-fired power plant instead of coal-fired power plant. The cost of NG-fired generation is about 1.25 times higher than that of coal-fired generation. This is because South Korea imports almost all of NG that is consumed from abroad using liquefied NG (LNG)-shipping vessels and the liquification requires too much cost.

South Korean customers have no choice about a power company in electricity market because of the existence of only one electricity seller in market. However, South Korean government can replace coal with NG using regulation and/or incentive schemes on generation companies. This inevitably causes an increase in the production costs of electricity and a rise in electricity price. At the macroeconomic level, it is an established fact that residential energy consumption behaves differently from industrial energy consumption and has different impact on the economy [5]. For example, the household acceptability of replacing coal with NG is quite important to making any decisions in the case of deciding whether green pricing demanding a rise in electricity price caused by the replacement of coal with NG should be introduced or not. The replacement can be successfully done only if South Koreans accept an increase in generation costs, due to the replacement. Clearly, the household preference for replacing coal with NG to achieve CO_2 emissions reduction can be a good guide for wide-ranging investigation of the replacement of high carbon energy source and decisions on replacing coal with NG.

If we use a contingent valuation (CV) technique, people's additional willingness to pay (WTP) for the replacement through an increase in their current electricity bills can be assessed. The WTP represents household preference for or acceptability of replacing coal with NG with a view to reducing CO_2 emissions. The household WTP implies the degree of the household WTP or the acceptability of replacing coal with NG. Thus, the policy-makers demand information about the household WTP for the replacement for the purpose of mitigating CO_2 emissions.

This study attempts to derive information about the household WTP or acceptability for replacing coal with NG. More specifically, this paper tries to examine the household WTP for the replacement using the CV approach. The remainder of this article is composed of four parts. The next section describes the methodology that is employed in this study. The third section is devoted to presenting the WTP model. The fourth section presents and discusses the results. Conclusions are contained in the final section.

2. Methodology

2.1. CV Method

No research has specifically examined the public valuation of replacing coal with NG in the literature. Thus, the issue should be dealt with here while using a proper method. The literature shows that the public WTP has been measured through stated preference methods, such as CV or choice experiment (CE) [6,7]. The stated preference techniques usually elicit people's WTP for the goods or service concerned directly and indirectly, respectively. This paper attempts to look into the household WTP for replacing coal with NG for electricity generation using the CV approach. This is because the most frequently applied to handling the public WTP is the CV technique. The CV method is grounded in the theory of consumer choice in microeconomics [8,9].

We can compare this study with the existing studies in four ways. First, there is a lack of researches that measured the additional WTP for electricity generated from NG instead of coal to reduce CO_2

emissions in the literature. Most of studies have dealt with the replacement of traditional fossil fuels with renewable energies (e.g., [10–16]). Second, the use of the CV method is consistent with the experience of some related former studies since the method is most frequently adopted in the literature. We can easily obtain a welfare measure by conducting a CV survey and then statistically looking into the data from the CV survey. Third, lots of recommendations for the use of the CV method given in Arrow et al. [17] and the literature are fully reflected in our study, as will be described in detail in next subsections. Fourth, both dealing with response bias and modeling zero WTP responses are more carefully examined in this study. Single-bounded (SB) dichotomous choice (DC) question is employed to alleviate response bias that can occur when using double-bounded (DB) DC question. In addition, the spike model that is presented in Kriström [18] is adopted to pay a close attention to modeling zero WTP values. Therefore, the joint use of an SB question and the spike model is tried.

2.2. Sampling and Survey Instrument

The sampling framework was based on the population characteristics found in Statistics Korea [19]. A supervisor affiliated with a professional polling firm took charge of the sampling and designed stratified random sampling. There were sixteen strata since South Korea is made up of sixteen provinces. That is, each province corresponded to each stratum. Within each stratum random sampling was performed. The sampled households consist of married couples or single/unmarried persons. The CV survey was implemented during May 2017. The supervisor and we educated the interviewers to conduct the CV survey well. They visited the interviewees' house, presented the survey questionnaire to them, and asked them to complete the survey questionnaire.

We have tested an initial version of survey questionnaire to check for its understandability and clarity for respondents. To this end, a focus group interview of 30 persons was carried out. With the help of the outcomes of the focus group interview, we could finalize the correction and refinement of the questionnaire. The final version of the CV questionnaire was structured in the following order. First, the purpose of the CV survey is explained and the background information is conveyed to help the respondents to understand the purpose. Second, some questions asking about respondents' perceptions and judgments concerning the replacement are presented. Third, some questions on the WTP for replacing coal-fired power with NG-fired power to mitigate CO_2 emissions in South Korea are provided to the respondents. Finally, some questions to obtain information about the respondents' characteristics are also asked.

2.3. Elicitation of WTP

This study used a DC question method adopting Hanemann's [20] recommendation. The DC question enables the respondents to easily respond to the questions regarding the respondents' WTP for replacing coal-fired power with NG-fired power to mitigate CO_2 emissions. Moreover, the question can derive an incentive-compatible response from the respondent. Typically, the interviewee is asked to answer whether she/he has willingness to pay a specified amount to implement the replacement or not. The response simply belongs to "yes" or "no". In the literature, the DC question format is preferred to an open-ended question format for several reasons [21–23]. Usually, DC question is used as one of two formats: a SB DC format and a DB DC format. In terms of reducing response bias, the former is superior to the latter [21,24,25]. Therefore, this study employs the SB DC format instead of the DB DC format to avoid any response bias arising from the second question that is required in the DB DC format.

2.4. Payment Vehicle

The scenario and questions used in the CV survey are hypothetical, and thus the respondents may have difficulties in answering the CV questions. One powerful approach to avoid the problems arising from the hypothetical situation is to adopt an appropriate payment vehicle and then insert it into the CV questionnaire survey. The payment vehicle should possess some desirable properties, such as persuasiveness, understandability, and familiarity to the respondents. This study determined to use monthly electric charges as the payment vehicle because it is clearly connected with the replacement of coal with NG. This is because the households will bear the costs by means of electric charges if the replacement is implemented. The WTP question was "If the replacement would certainly be implemented, are you willing to pay a given amount for replacing coal-fired power with NG-fired power to reduce CO_2 emissions through an increase in monthly electric charges?"

3. WTP Model

3.1. Basic Model

Hanemann [20] suggested a model for dealing with SB DC CV data, namely the random utility maximization model, which is the most popular model in the CV literature. The model uses the common sense that if the respondent report "yes" to a proposed bid to implement the replacement, then the respondent's utility when the replacement is implemented is more than that when the replacement is not implemented. For more detail, refer to Hanemann [20], on which the following explanation basically relies.

A_j means the bid presented to interviewee j. Y_j indicates her/his WTP. There can be two results. The first is "yes", when $Y_j \geq A_j$. The second is "no", when $Y_j < A_j$. In this regard, we can introduce a variable, I_j^Y, the value is one if household j's response is "yes" and zero if not. Rather than simply applying Hanemann's [20] model, we try to focus on the property of the "no" response and use the spike model proposed by Kriström [18] because we consider that the "no" responses are made up of $0 < Y_j < A_j$ and $Y_j = 0$.

In other words, one more issue that is to be considered in modeling the WTP responses is that a number of respondents can report zero WTP. The households who reported "no" to a given bid was asked one more question verifying if Y_j is positive and less than A_j or zero. There two possible outcomes, "no–yes" and "no–no". The former denotes $0 < Y_j < A_j$, and the latter implies $Y_j = 0$. Thus, we need to introduce one more binary variable, I_j^{TY}, which takes one when interviewee j answered "yes" to the question and zero if not.

3.2. Spike Model

A total of 396 respondents among 1000 respondents gave zero WTP responses, which will be reported below. Therefore, this study uses the spike model [18,26] for the purpose of analyzing the WTP data with zero values. Let the distribution function of the WTP for the model be $H_Y(\cdot)$. It is formulated as:

$$H_Y(A;\gamma_0,\gamma_1) = \begin{cases} [1+\exp(\gamma_0-\gamma_1 A)]^{-1} & \text{if } A > 0 \\ [1+\exp(\gamma_0)]^{-1} & \text{if } A = 0 \\ 0 & \text{if } A < 0 \end{cases} \tag{1}$$

where γ_0 and γ_1 are the parameters of $H_Y(\cdot)$.

Equation (1) produces three cases. First, the probability of the WTP being less than A is $[1+\exp(\gamma_0-\gamma_1 A)]^{-1}$. Second, that of the WTP being zero is $[1+\exp(\gamma_0)]^{-1}$, which is called the spike. Third, that of the WTP being negative is zero. This case may be controversial because someone can feel disutility by replacing coal with NG. For example, she/he can work for a company that generates electricity by coal and the replacement can induce a decrease in her/his income. In spite of that, we ignore the possibility of negative WTP in this study considering that a subsidy cannot be granted to those who have negative WTP. For a conservative approach, their WTP is assumed to be not negative but zero. Let T be the sample size. The log-likelihood function for the spike model can be expressed as:

$$\begin{aligned} \ln L = & \sum_{j=1}^{T} \{ I_j^Y \ln[1 - H_Y(A_j^U; \gamma_0, \gamma_1)] \\ & + (I_j^{YN} + I_j^{NY}) \ln[H_Y(A_j^U; \gamma_0, \gamma_1) - H_Y(A_j^L; \gamma_0, \gamma_1)] \\ & + I_j^{TY} (I_j^N + I_j^{NN}) \ln[H_Y(A_j^L; \gamma_0, \gamma_1) - H_Y(0; \gamma_0, \gamma_1)] \\ & + (1 - I_j^{TY})(I_j^N + I_j^{NN}) \ln H_Y(0; \gamma_0, \gamma_1) \} \end{aligned} \quad (2)$$

The maximum likelihood (ML) estimator is defined as the values for γ_0 and γ_1, maximizing Equation (2). It is a well-known fact that the ML estimator satisfies the conditions of both consistency and asymptotically efficiency. If we use Equation (1) and a formula for computing the mean, the mean WTP can be easily derived. That is, the mean WTP can be calculated using the following equation.

$$E(Y) = \int_0^\infty [1 - H_Y(A; \gamma_0, \gamma_1)] dA - \int_{-\infty}^0 H_Y(A; \gamma_0, \gamma_1) dA = (1/\gamma_1) \ln[1 + \exp(\gamma_0)] \quad (3)$$

4. Results and Discussion

4.1. Data

A focus group interview was carried out to sketch the distribution of the WTP. Trimming 15% observations from both tails of the distribution, and then choosing some bids from the remaining distribution gives us a set of seven bids, one of which was randomly presented to the respondents. The list of bids is KRW 10, 20, 30, 40, 60, 80, and 100. USD 1.0 was equal to KRW 1125 when the survey was performed. In all, 1000 useable observations were obtained. The data were checked for internal consistency and have no missing items. Moreover, some of the supervisors from the survey company telephoned all of the respondents and asked whether they had responded honestly to the survey or not. Table 1 describes the number of the responses corresponding to each bid. 274, 330, and 396 respondents stated "yes", "no–yes", and "no–no", respectively. Thus, 39.6% of the respondents reported zero WTP for replacing coal with NG. This confirms that we need to apply the spike model.

Table 1. Distribution of responses by bid amount.

Bid Amount [a]	Sample Size [b]	Number of Responses (%)		
		"Yes" Votes	"No–Yes" Votes	"No–No" Votes
10	143 (100.0%)	93 (65.0%)	10 (7.0%)	40 (28.0%)
20	143 (100.0%)	65 (45.5%)	26 (18.2%)	52 (36.4%)
30	143 (100.0%)	45 (31.5%)	50 (35.0%)	48 (33.6%)
40	143 (100.0%)	36 (25.2%)	50 (35.0%)	57 (39.9%)
60	143 (100.0%)	16 (11.2%)	71 (49.7%)	56 (39.2%)
80	142 (100.0%)	10 (7.0%)	59 (41.5%)	73 (51.4%)
100	143 (100.0%)	9 (6.3%)	64 (44.8%)	70 (49.0%)
Totals	1000 (100.0%)	274 (27.4%)	330 (33.0%)	396 (39.6%)

[a] The unit is Korean won per kWh of electricity use, and when the survey was performed USD 1.0 equaled KRW 1125; [b] The number in parentheses indicates the percentage of sample size.

4.2. Estimation Results of the Model

Table 2 contains the estimation results of the model. The estimated coefficient for the bid amount has statistical significance. Its negative sign indicates the higher bid amount the more the likelihood of the interviewee's responding "yes" to a given bid. The spike is computed to be 0.3974, which is equivalent to the sample proportion (39.6%). The Wald statistic can reject the hypothesis that the estimated equation is insignificant. The mean additional WTP for the replacement is calculated to be

KRW 25.35 (USD 0.02) per kWh of electricity consumption. The confidence intervals for this value are also reported in Table 2. These are estimated by the use of Krinsky and Robb's [27] approach.

Table 2. Estimation results of the willingness to pay (WTP) model.

Variables	Coefficient Estimates [d]
Constant	0.4162 (6.48) **
Bid amount [a]	−0.0364 (−20.28) **
Spike	0.3974 (25.83) **
Mean additional WTP per kWh	KRW 25.35 (USD 0.023)
t-value	19.05
95% confidence interval [b]	KRW 23.02–28.17 (USD 0.020–0.025)
99% confidence interval [b]	KRW 22.25–29.12 (USD 0.020–0.026)
Number of observations	1000
Log-likelihood	−985.53
Wald statistic (*p*-value) [c]	411.61 (0.000)

[a] The unit is Korean won, and USD 1.0 equaled KRW 1125; [b] The confidence intervals are calculated by the use of Krinsky and Robb's [27] approach with 5000 replications; [c] The null hypothesis is that the estimated equation is insignificant and the corresponding *p*-value is presented in the parentheses beside the statistic; [d] The *t*-values are reported in parentheses beside the coefficient estimates; ** indicates statistical significance at the 1% level.

4.3. Estimation Results of the Model with Covariates

For the purpose of investigating the influence of covariates on the likelihood of answering "yes" to a given bid, we estimate the model, including covariates. Some of the variables used for the covariates are explained in Table 3. Their sample statistics are also reported in Table 3. The estimation results are contained in Table 4. If the sign for the coefficient corresponding to a variable is positive, the value of the variable is correlated with the probability of answering "yes" to a proposed bid. If it is negative, then the value of the variable has a negative relation to the probability of answering "yes" to a suggested bid.

Table 3. Definitions and sample statistics of the variables.

Variables	Definitions	Mean	Standard Deviation
Nuclear	Dummy for the respondent's agreeing that any additional new nuclear power plants should not be constructed and the planned life of any existing nuclear power plant should not be extended. (0 = no; 1 = yes)	0.64	0.48
Education	The respondent's education level in years	14.23	2.28
Income	The household's monthly income before tax deduction (unit: KRW 1 million = USD 889)	4.40	2.01
Electricity	The respondent's household's monthly electricity consumption (unit: 100 kWh)	2.78	0.68

For example, the estimated coefficients concerning Nuclear and Education variables are positive. One who agreed that additional new nuclear power plants should not be constructed, and the planned life of any existing nuclear power plant should not be extended more likely tends to state "yes" to a proposed bid than others. Moreover, the higher the education level the greater the likelihood of answering "yes" to a suggested bid. The estimated coefficient for Income variable is positive, but the coefficient estimate for Electricity variable is negative. Household income has a positive correlation, with the likelihood of reporting "yes" to an offered bid. This finding makes sense because the reduction of CO_2 emissions by replacing coal with NG is a normal goods. For example, a number of studies (e.g., [10,14,16,28,29]) show that the sign for Income variable is positive. As the monthly electricity consumption of the respondent becomes higher, the likelihood of the household's reporting "yes" to a provided bid grows lower. This shows that the households with higher monthly electricity consumption less likely tend to state "yes" to a proposed bid than others.

Table 4. Estimation results of the spike model with covariates.

Variables	Coefficient Estimates	t-Values
Constant	−1.8147	−3.90 **
Bid [a]	−0.0404	−20.58 **
Nuclear	1.2788	9.53 **
Education	0.1189	4.19 **
Income	0.0830	2.37 *
Electricity	−0.2156	−2.20 *
Spike	0.3871	23.76 **
Mean additional WTP per kWh	KRW 23.47 (USD 0.021)	
t-value	19.57	
95% confidence interval [b]	KRW 21.26–26.04 (USD 0.019–0.023)	
99% confidence interval [b]	KRW 20.68–26.98 (USD 0.018–0.024)	
Wald statistic (p-value) [c]	141.29 (0.000)	
Log-likelihood	−444.78	
Number of observations	1000	

[a] The unit is Korean won, and USD 1.0 equaled KRW 1125; [b] The confidence intervals are calculated by the use of Krinsky and Robb's [27] approach with 5000 replications; [c] The null hypothesis is that the estimated equation is insignificant and the corresponding p-value is presented in the parentheses beside the statistic; * and ** indicate statistical significance at the 5% and 1% levels, respectively.

5. Conclusions

Currently, coal is the biggest generation source in South Korea. For example, 46.6% of electricity consumed in the country was generated from coal during September 2017. South Korea, being the eighth largest CO_2 emitter in the world, pledged to mitigate 37% of CO_2 emissions by 2030 using a variety of instruments. One effective instrument is to replace high carbon power sources such as coal with low carbon power sources such as NG, which is nearly half of carbon content per unit of energy than coal. The switch of electricity generation source from coal with NG and renewables can significantly reduce CO_2 emissions. Therefore, South Korean government planned to replace some amount of coal with NG for electricity generation.

Our study sought to investigate the household WTP for the replacement, applying a CV technique using a nationwide survey of 1000 respondents. The study employed an SB DC model to derive WTP responses from those sampled. Furthermore, the spike model was utilized to analyze the WTP responses, ensuring a good fit for the CV data. Two parameter estimates in the model and the estimate for the spike exhibited statistical significance. In addition to the current electricity price, KRW 121.52 (USD 0.11) per kWh, the respondents were willing to pay KRW 25.35 (USD 0.02) per kWh. The costs of NG-fired and coal-fired generation are KRW 100.13 and 78.05, respectively, per kWh. The difference between the two is KRW 22.08 per kWh, which is smaller than the mean additional WTP (KRW 25.35 per kWh). The household's additional WTP is bigger than the actual additional cost. This vividly portrays that South Korean households are readily willing to pay some amount that is more than the costs arising from the replacement to decrease CO_2 emissions. It is concluded that the switch of power generation source from coal to NG to reduce CO_2 emissions can be supported by South Korean households. Thus, the South Korean government should consider pushing ahead with the switch immediately.

As the effects of the covariates on the probability of reporting "yes" to an offered bid could give insightful information to policy makers, the meaning of the socioeconomic factors that are examined above should be addressed here. The respondents who agreed that additional new nuclear power plants should not be constructed and the planned life of any existing nuclear power plant should not be extended had more likelihood to report "yes" to a presented bid than others. This implies that those who had a negative view of nuclear power plants also had a negative view of coal-fired power plants. Both the education level of the respondent and household income has a positive correlation with the probability of stating "yes" to a proposed bid. This indicates that more educated and richer people supported the replacement of coal with NG to reduce CO_2 emissions than others. Interestingly, the more the respondent's household's monthly electricity consumption the less the respondent's tendency to answer "yes" to an offered bid. It appears that big consumers of electricity were concerned about the increase in electric charges that is caused by the switch of generation source from coal to NG.

As a next step of the study, its framework can be extended to the inclusion of multiple attributes that are arising from the switch. For example, the emissions of air pollutants, such as sulfur oxides, nitrogen oxides, ozone, particulate matters, human health effects, such as mortality and morbidity, agriculture production, material damages, and so on can be further considered. CE technique is a good candidate for dealing with the issue because CE is quite useful in valuing a multi-dimensional or multi-attribute goods [30,31]. Although the CV approach that is adopted in this study provides information about the value arising from just a specified change, the CE approach can supply information about the value arising from a variety of changes.

Acknowledgments: This study was supported by the Research Program funded by the SeoulTech (Seoul National University of Science and Technology).

Author Contributions: All the authors significantly contributed to writing the paper. Seul-Ye Lim proposed the research ideas and analyzed the data statistically. Hyo-Jin Kim wrote Methodology and Results sections; and Seung-Hoon Yoo gathered the data used here and revised an earlier version of the paper.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. European Commission. CO_2 Time Series 1990–2015 per Region/Country. Available online: http://edgar.jrc.ec.europa.eu/overview.php?v=CO2ts1990-2015 (accessed on 7 April 2017).
2. United Nations Framework Convention on Climate Change. Available online: http://unfccc.int (accessed on 10 April 2017).
3. International Energy Agency. CO_2 Emissions from Fuel Combustion. Available online: https://www.iea.org (accessed on 11 September 2017).
4. Korea Electric Power Corporation. *Statistics of Electric Power in Korea*; Korea Electric Power Corporation: Naju, South Korea, 2016.
5. Narayan, S.; Doytch, N. An investigation of renewable and non-renewable energy consumption and economic growth nexus using industrial and residential energy consumption. *Energy Econ.* **2017**, *68*, 160–176. [CrossRef]
6. Lim, S.-Y.; Lim, K.-M.; Yoo, S.-H. External benefits of waste-to-energy in Korea: A choice experiment study. *Renew. Sustain. Energy Rev.* **2014**, *34*, 588–595. [CrossRef]
7. Knapp, L.; Ladenburg, J. How spatial relationships influence economic preferences for wind power—A review. *Energies* **2015**, *8*, 6177–6201. [CrossRef]
8. Kim, H.-J.; Lim, S.-Y.; Yoo, S.-H. Is the Korean public willing to pay for a decentralized generation source? The case of natural gas-based combined heat and power. *Energy Policy* **2017**, *102*, 125–131. [CrossRef]
9. Yoo, S.-H.; Kwak, S.-J.; Kim, T.-Y. Assessing benefits from greenhouse gas emission reduction policy: A pilot case study of Korea. *Int. J. Environ. Pollut.* **2001**, *15*, 553–567. [CrossRef]
10. Lee, C.Y.; Heo, H.J. Estimating willingness to pay for renewable energy in South Korea using the contingent valuation method. *Energy Policy* **2016**, *94*, 150–156. [CrossRef]
11. Alberini, A.; Bigano, A.; Ščasný, M.; Zvěřinová, I. Preferences for energy efficiency vs. renewables: What is the willingness to pay to reduce CO_2 emissions? *Ecol. Econ.* **2018**, *144*, 171–185. [CrossRef]
12. Yoo, S.-H.; Kwak, S.-Y. Willingness to pay for green electricity in Korea. *Energy Policy* **2009**, *37*, 5408–5416. [CrossRef]
13. Lee, J.-S.; Yoo, S.-H.; Kwak, S.-J. Public's willingness to pay for preventing climate change. *Appl. Econ. Lett.* **2010**, *17*, 619–622. [CrossRef]

14. Lim, H.-J.; Yoo, S.-H. Train travel passengers' willingness to pay to offset their CO_2 emissions in Korea. *Renew. Sustain. Energy Rev.* **2014**, *32*, 526–531. [CrossRef]
15. Song, T.-H.; Lim, K.-M.; Yoo, S.-H. Estimating the public's value of implementing the CO_2 emissions trading scheme in Korea. *Energy Policy* **2015**, *83*, 82–86. [CrossRef]
16. Cheng, Y.S.; Cao, K.H.; Woo, C.K.; Yatchew, A. Residential willingness to pay for deep decarbonization of electricity supply: Contingent valuation evidence from Hong Kong. *Energy Policy* **2017**, *109*, 218–227. [CrossRef]
17. Arrow, K.; Solow, R.; Portney, P.R.; Leamer, E.E.; Radner, R.; Schuman, H. Report of the NOAA panel on contingent valuation. *Fed. Regist.* **1993**, *58*, 4601–4614.
18. Kriström, B. Spike models in contingent valuation. *Am. J. Agric. Econ.* **1997**, *79*, 1013–1023. [CrossRef]
19. Statistics Korea. Available online: http://kosis.kr (accessed on 7 April 2017).
20. Hanemann, W.M. Welfare evaluations in contingent valuation experiments with discrete responses. *Am. J. Agric. Econ.* **1984**, *66*, 332–341. [CrossRef]
21. Bateman, I.J.; Langford, L.H.; Jones, P.; Kerr, G.N. Bound and path effects in double and triple bounded dichotomous choice contingent valuation. *Ressour. Energy Econ.* **2001**, *23*, 191–213. [CrossRef]
22. Champ, P.A.; Boyle, K.J.; Brown, T.C. *A Primer on Nonmarket Valuation*; Kluwer Academic Publishers: Dordrecht, The Netherlands, 2004.
23. Johnston, R.J.; Boyle, K.J.; Adamowicz, W.; Bennett, J.; Brouwer, R.; Cameron, T.A.; Hanemann, W.M.; Hanley, N.; Ryan, M.; Scarpa, R.; et al. Contemporary guidance for stated preference studies. *J. Assoc. Environ. Resour. Econ.* **2017**, *4*, 319–405. [CrossRef]
24. Hanemann, W.M.; Loomis, J.; Kanninen, B.J. Statistical efficiency of double-bounded dichotomous choice contingent valuation. *Am. J. Agric. Econ.* **1991**, *66*, 1255–1263. [CrossRef]
25. Carson, R.T.; Groves, T.; Machina, M.J. Incentive and informational properties of preference questions. *Environ. Resour. Econ.* **2007**, *37*, 181–210. [CrossRef]
26. Yoo, S.-H.; Kwak, S.-J. Using a spike model to deal with zero response data from double bounded dichotomous contingent valuation survey. *Appl. Econ. Lett.* **2002**, *9*, 929–932. [CrossRef]
27. Krinsky, I.; Robb, A.L. On approximating the statistical properties of elasticities. *Rev. Econ. Stat.* **1986**, *68*, 715–719. [CrossRef]
28. Lim, S.-Y.; Kim, H.-J.; Yoo, S.-H. Household willingness to pay for expanding fuel cell power generation in Korea: A view from CO_2 emissions reduction. *Renew. Sustain. Energy Rev.* **2018**, *81*, 242–249. [CrossRef]
29. Oerlemans, L.A.G.; Chan, K.-Y.; Volschenk, J. Willingness to pay for green electricity: A review of the contingent valuation literature and its sources of error. *Renew. Sustain. Energy Rev.* **2016**, *66*, 875–885. [CrossRef]
30. Menegaki, A.N.; Olsen, S.B.; Tsagarakis, K.P. Towards a common standard—A reporting checklist for web-based stated preference valuation surveys and a critique for mode surveys. *J. Choice Model.* **2016**, *18*, 18–50. [CrossRef]
31. Yang, H.-J.; Lim, S.-Y.; Yoo, S.-H. The environmental costs of photovoltaic power plants in South Korea: A choice experiment study. *Sustainability* **2017**, *9*, 1773. [CrossRef]