

The Study on the Value of New & Renewable Energy as a Future Alternative Energy Source in Korea

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Abstract. The main objective of this study is to estimate the value of Renewable Energy in Korea by extracting the people's willingness to pay (WTP) for the Renewable Energy. Moreover, we try to find the factors that have an impact on the WTP and study the relation between factors and WTP. We use the contingent valuation methodology (CVM) to find the value of renewable energy. As a result, the per capita value of renewable energy is measured by 38,921 won, and renewable energy was affected by ethical factors largely. Finally, if constructing the renewable energy facilities instead of nuclear facilities, it requires additional 40 trillion won approximately. Therefore, it is hard to promote renewable energy generation in recognition of our country's public, yet.

Keywords: new & renewable energy, CVM, WTP

1 Introduction

The global warming problem is mainly caused by the greenhouse gases that consist primarily of carbon dioxide (CO₂). Therefore, it is trend that many countries try to develop the alternative energy rather than consuming the fossil fuels to mitigate the global warming, recently. Sims et al. (2003) discussed the alternative energy sources that are available from a cost-effective perspective. The results showed that nuclear power and renewable energy have the similar potentials such as the cost-effectiveness and emission reduction [5]. However, after the Fukushima nuclear disaster, many countries are to diminish the ratio of nuclear power. In case of Korea, the government announced the plan which increasing the ratio of nuclear power up to 41% by 2030 in 2008, but modified the plan to maintain the ratio of nuclear power by 22~29% which is present level, in 2013. On the other hand, as we experiment the worst power shortage caused by increasing annual power consumption in summer 2013, it is necessary to construct nuclear plants which can provide the energy more inexpensively. Although South Korea is not bureau of the Kyoto Protocol reduction, it

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legislated 'Low Carbon, Green Growth' as an act to collaborate international cooperation to respond to climate change on April 14, 2010. Its main purpose is that the country provides penalties and incentives to make energy companies to reduce greenhouse gas emissions, and promotes renewable energy industrialization and increases penetration ratio of renewable energy for increasing Korea's energy independence. Recently, renewable energy has been highlighted as the environment-friendly development because it is less likely to be depleted and generate its greenhouse gas. However, renewable energy is conducted as a secondary energy because of some reasons. The first thing is the high investment cost about technology development compared to other power generation facilities and the second is the problem of the country's area such as terrain conditions. Ultimately, it is necessary that we have to solve the problem of economy of renewable energy to entirely replace nuclear or thermal power generation with renewable energy as a future alternative energy.

According to the Korea Hydro & Nuclear Power Company, the unit cost of nuclear power generation is 39.61 won, and renewable energy is 118.66 based on 2012 year. In other words, renewable energy is three times higher than nuclear energy. Also, when the renewable energy expanded to add 10GW, it needs the additional cost of 17.1% which is more than the existing plan. Moreover, the major cause of increasing the cost is the need for an additional backup facility caused by the nature of the power generation source which does not generate energy sustainably. Nevertheless, renewable energy is the spotlight as the source that can reduce greenhouse gas emissions and can be developed to eliminate the fear of nuclear power plants after Fukushima crisis. Therefore, when compared to renewable energy and nuclear power as a future alternative energy, it is hard to compare two sides by the only one factor which is the unit cost of power generation. It is necessary that the social costs have to be considered besides the unit cost of power generation regarding estimating the nuclear cost. In other words, we have to obtain more valid to consider the value of direct cost and external factors (social cost) as the risk about a high-risk power generation source such as nuclear when comparing nuclear and renewable energy.

In this study, we regard these external factors as a social cost and measure the value of renewable energy from people who perceive the social cost.

2 Contingent Valuation Method (CVM)

Market data are not available for public services or for services that are offered for free. In such situations, it is necessary to use a procedure that does not rely on market data. CVM has been proposed in the environmental literature for such situations [2] and is one of the most famous techniques for measuring and analyzing the value of public [7]. CVM is a survey-based economic technique for the valuation of non-market goods and services. While these give peoples' utility, certain aspects of them do not have a market price as they are not sold directly. CVM has been widely used by government departments when performing cost-benefit analysis of projects impacting on the environment. Now, it is widely accepted as a real estate appraisal technique [4].

Typically CVM asks how much money people would be willing to accept (or willing to pay) to be compensated for the loss of (or maintain the existence of) a non-market goods or services feature. WTA is the amount of money that a user is willing to accept to abandon a good/service or to endure something negative, such as environmental pollution or invasion of privacy. It is the minimum monetary amount required for the sale of a good/service or acquisition of something undesirable to be accepted by an individual. Conversely, willingness to pay (WTP) is the opposite notion with WTA. Some methods have been modified to measure consumer WTP. Thus, the price of any goods/services transaction will be any point between a buyer's WTP and a seller's WTA. The social surplus is generated by the trading of goods/services from the net difference between WTP and WTA. Alternative techniques for estimating WTA have been proposed and used in the marketing literature, including the choice-based experiments such as conjoint analysis. Although each approach has its own advantages and disadvantages, along with their own set of detractors [1] and supporters [3].

Establishing CVM can be distinguished in 5 steps. Step1 selects a research target, and defines the valuation problem and select non-market resource. Step 2 is the construction of a hypothetical market. First, the main idea is to construct a scenario which corresponds as closely as possible to a real situation. The scenario contains precisely the reason for payment with standard market goods or services, and must be understood by the respondent. Second, it constructs a method of payment that fulfills conditions with respect to incentive compatibility, realism, and subjective justice among respondents. Third, it constructs a provision rule by which the good is to be provided, as a function of the stated value. Step 3 designs survey questionnaire. First, a CVM researcher selects a limited sample of the underlying population, and presents possible bidding mechanism. The several types of possible bidding mechanisms are open-ended question, bidding game, payment card, Dichotomous-choice (DC) question. First, bidding game asks a sequence of questions until maximum WTP or minimum WTA is found. Payment card presents average expenses of other goods per a household, and induce respondents into answering their WTP or WTA for research object. The card indicates a range of possible values, one of which is pointed out by the interviewee. Open-ended question leads the respondent directly insist their WTP or WTA without options. Dichotomous-choice (DC) question presents two kinds of methods. Single-bound dichotomous choice (SBDC) provides little information only one bound. Double bound dichotomous choice (DBDC) same as SBDC, but an additional follow-up question is required. This amount of price is previously determined by 'Open-end' method. In case of WTA, respondents are supposed to choose "NO" if the price is higher than they can accept, and choose "Yes", if not.

Table 1. Application procedure of CVM

Steps	Contents
Step 1. Research target selection	Define the valuation problem and select non-market resource
Step 2. Scenario Selection	Create a hypothetical market

Step 3. Survey questionnaire design	Present a hypothetical scenario describing the change in the good to be valued Present the hypothetical payment mechanism and related stipulations Elicit the respondent's WTP or WTA ("bid elicitation procedure") Collect information on respondents' socioeconomic characteristics
Step 4. Survey	Preliminary survey : Provide base initial bid for the main survey Main survey : In-person interviews may be conducted with random samples of respondents
Step 5. Survey result analysis	The data must be input and analyzed to conduct statistical methods appropriate for the type of question to estimate public WTP or WTA Identify possible non-response bias

Step 4 conducts the survey written in Step3. In person interviews may be conducted with random samples of respondents. Step 5 conducts the survey result analysis estimating average WTP or WTA, bid curves, and aggregating the data. The data must be input and analyzed to conduct statistical methods appropriate for the type of question to estimate public WTP or WTA. The application procedure of CVM is arranged in Table 1.

3 Methodology

In this paper, we conducted the multiple regression about the reason in favor of renewable energy generation, the willingness to replace the nuclear power, the willingness to take the cost, sex and age to investigate the impact on the WTP along the individual characteristics.

$$WTP = \alpha + \beta_i AGREE_i + \gamma_k WILL_k + \theta_n DEMO_n + \delta GAIN + \epsilon$$

At the equation, Agree was divided into environmental factors, psychological factors, economic factors, and factors such as ethical reasons in favor of renewable energy generation, and Will is willing to accept the additional costs and also to replace the existing nuclear power plants with renewable energy. Demo refers to the age, sex, education, etc. demographic characteristics, and finally, Gain represents the individual income level.

4 Result

Table 2. Demographic characteristics

Division	Frequency (N=190)	Percentage (100%)
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Sex	Male	106	55.8%
	female	84	44.2%
age	Teenage	7	3.7%
	twenties	128	67.4%
	thirty	42	22.1%
	forty	12	6.3%
	Over fifty	1	0.5%
Academic background	High school diploma	15	7.9%
	Attending university	58	30.5%
	College graduates	48	25.2%
	Attending graduate school	52	27.4%
	Graduate school over	17	8.9%

Table 3. Multiple Regression

variables	β	t	vif	
The reasons in favor of renewable energy generation	Environmental factor	-35154	-1.705 *	1.323
	Psychological factor	-35296	-1.963 *	1.478
	Economic factor	-27570	-1.880 *	1.613
WTR *	-5526	-0.615	1.554	
WTA **	33121	3.475 ***	1.627	
Age	-2821	-0.277	1.425	
Sex	1124	0.095	1.042	
Academic background	-11323	-1.894 *	1.361	
Income level	0.001	0.718	1.241	

*(p<0.1), **(p<0.05), ***(p<0.01)

Dependent variable = WTP

Excluded variable = ethical variable

* WTR = willingness to replace nuclear power with renewable energy

** WTA = willingness to accept the additional costs

R² = 0.131(0.088)

As a result, the biggest factor in favor of renewable energy generation to the individual is an ethical factor which is the most meaningful as a sense of responsibility to the future generations. In particular, by expressing the willingness to accept the cost for the descendants strongly, the cognition for renewable energy development is more meaningful in the ethical factors than economic factors. Characteristically, the higher educated group is shown to be a negative effect on the WTP, which is determined probably because the relatively highly educated group more consider other factors than the ethical factor. In addition, the per capita value of renewable energy was measured by 38,921 won. After all, when replacing the nuclear

power with the renewable energy plants in our country, it was estimated at an additional cost of annually about 2 trillion won (38,921 won * population 50 million). However, the total annual sales of nuclear power is approximately 20 trillion won based on 2012, and the unit cost of renewable energy generation is three times expensive when constructing the renewable energy plants instead of the nuclear power plants, typically. So, in this case, it requires approximately 40 trillion won. Therefore, because the economics of renewable energy are still being inferior to nuclear power, it is hard to promote renewable energy generation in recognition of our country's public.

References

1. Diamond, P.A. & Hausman, J.A.: Contingent Valuation: Is Some Number better than No Number? *The journal of Economic Perspectives*. Vol. 8, Issue 4, pp.45-64 (1994)
2. Hanemann, W. M.: Welfare evaluation in contingent valuation experiments with discrete responses. *American Journal of Agricultural Economics*. 66, pp.332-341 (1984)
3. Hanemann, W. M.: Valuing the environment through contingent valuation. *Journal of Economic Perspectives*. 8(4), pp.19- 43 (1994)
4. Mundy, Bill and Dave McLean.: Using the Contingent Value Approach for Natural Resource and Environmental Damage Applications. *The Appraisal Journal*. July 1998, pp.88-99 (1998)
5. Lafta, Tamara. : Attitudes towards Nuclear Power in Sweden (2013)
6. Sims R., H. Rogner, K. Gregory.: Carbon emission and mitigation cost comparisons between fossil fuel, nuclear and renewable energy resources for electricity generation. *Energy Policy* 31, p.p. 1315–1326 (2003)
7. Wertenbroch, Klaus and Bernd Skiera.: Measuring Consumers' Willingness to Pay at the Point of Purchase. *Journal of Marketing Research*. 39 (May), pp.228–4 (2002)