

The External Cost Evaluation of the Nuclear Severe Accident Using CVM

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1. Introduction

The external cost of energy can be defined as "the cost not included in the energy market price", such as air pollution, noise, etc. Within the evaluation of the external cost of nuclear energy, the estimation of the external cost of severe accident is one of the major topics to be addressed.

For the evaluation of the external cost of severe accident, the effect of risk aversion of the public against the severe accident must be addressed, because people are more concerned about low probability - high consequence events than about high probability - low consequence events having the same mean damage. It is generally recognized that there is a discrepancy between the social acceptability of the risk and the average monetary value which corresponds in principle to the compensation of the consequences for each individual of the population affected by the accident [1]

In this paper, the CVM (Contingent Valuation Method) is used to integrate the risk aversion in the external costs of nuclear severe accidents in Korea.

2. Background

The methodological issues raised by the assessment of external costs led the European Commission and the United States Department of Energy to launch in the early 1990s a joint research project ExternE (Externalities of Energy) to address those issues and identify a relevant methodology for estimating the external costs of energy [2].

For the nuclear electricity generation, the problem of evaluating the external cost of nuclear severe accidents remains unresolved and controversial issues. Several recent studies have tried to integrate the risk aversion in the external costs of severe nuclear reactor accidents and several methods have been tested for this purpose, but no one has been considered acceptable.

One of the representative method to integrate the risk aversion in the external costs of severe nuclear reactor accidents was developed by Eeckhoudt et al.[3], and this was introduced in NEA report [1]. He used the risk aversion coefficient, mainly based on the analysis of financial risks in the stock markets to evaluate the external cost of nuclear severe accident. However, the use of financial risk aversion coefficient to nuclear severe accidents is not appropriate, because financial risk and nuclear severe accident risk are entirely different.

3. Analysis method and results

There have been several researches for evaluating the external cost of nuclear severe accidents, but no one has been considered acceptable so far. In this paper, the CVM is used to appropriately integrate the risk aversion of general public into the external cost of nuclear electricity generation in Korea.

The CVM involves directly asking people, in a survey, how much they would be willing to pay (WTP) for specific environmental services. It is called "contingent" valuation, because people are asked to state their willingness to pay, contingent on a specific hypothetical scenario and description of the environmental service. The CVM is used to estimate economic values for all kinds of ecosystem and environmental services. It can be used to estimate both use and non use values, and it is the most widely used method for estimating non-use values.

In this study, a questionnaire for general public was developed to find WTP for the nuclear severe accidents as shown in table 1. A WTP question for gas accidents was added in the questionnaire for validation of the survey results. For gas accidents, WTP survey already has been performed in Korea by KEEI (Korea Energy Economics Institute) in 1999 [4], so our survey results can be validated by comparing the WTP survey results for gas accidents with the KEEI results.

The information for gas and nuclear accidents, and the amount of money for public charges were provided in questionnaire as shown in table 1. It is to make general public be able to understand the gas and nuclear accidents, and answer the reasonable WTP. A total of 231 persons responded. Table 2 shows the derivation result for the external cost of nuclear severe accident, using WTP survey result. First, an average WTP for prevention of nuclear severe accident per household per month (9,144 Won, A) which is the main survey result for 231 persons was transformed to an average WTP per household per year (109,730 Won, B). Then, the total WTP per year in Korea for prevention of nuclear severe accident ($1.572E+12$ Won, D) was induced by multiplying a WTP per household per year (109,730 Won, B) to the total number of households in Korea in year 2004 (14,326,224 households, C). Finally, the external cost for nuclear severe accident (12.03 Won/kWh, F) was induced by dividing the total WTP per year in Korea for prevention of nuclear severe accident ($1.572E+12$ Won, D) by electricity generation per year by nuclear in Korea ($1.31E+11$ kWh, E).

Table 1. WTP survey question for nuclear and gas accident

Information
Information for gas accident :
 ○ The number of deaths by gas accidents are 435 persons from year 1993 to 2004 in Korea.
 ○ About more than 20 persons are dead by gas accident per year.

Information for nuclear accident :
 ○ The number of deaths by nuclear severe accidents are 0 persons in Korea.
 ○ The probability of occurrence of nuclear severe accident is less than one per a million year, and more than 1,000 persons can be dead if the nuclear accident occurs.

Question
 How much do you willing to pay per month for prevention of gas or nuclear accident ?

Gas Accident Indicate √ in blank □		Nuclear Accident Indicate √ in blank □
□ _____	More than 50,000 Won	□ _____
□ Heating bills (41,200 Won)	40,000 Won	□ _____
□ Electric charges (37,000 Won)	30,000 Won	□ _____
□ Phone charges (25,200 Won)	20,000 Won	□ _____
□ Water charges (14,300 Won)	10,000 Won	□ _____
□ _____	7,000 Won	□ _____
□ TVsubscription fee (6,400 Won)	5,000 Won	□ _____
□ _____	3,000 Won	□ _____
□ Newspaper fee (2,800 Won)	1,000 Won	□ _____
□ _____	500 Won	□ _____
□ Postage (250 Won)	100 Won	□ _____
□ _____	0 Won	□ _____

Table 2. Derivation table for external cost of nuclear severe accident

Variables	Symbol	Value	Unit
WTP for prevention of nuclear severe accident (per household, per month)	A	9,144	Won/Month
WTP for prevention of nuclear severe accident (per household, per year)	$B=A \times 12$	109,730	Won/Year
Total number of households in Korea	C	14,326,224	Households
Total WTP for prevention of nuclear severe accident in Korea (per year)	$D=B \times C$	1.572E+12	Won
Electricity generation by nuclear in Korea	E	1.31E+11	kWh
External cost for nuclear severe accident	$F=D/E$	12.03	Won/kWh

4. Validation of the survey results

For gas accidents, WTP survey has already been performed in Korea by KEEI in 1999, so our survey results can be validated by comparing with the WTP survey results of KEEI as shown in table 3.

The WTP for the KEEI study was 4,702 Won per month. On the other hand, the WTP of gas accidents for our study was 8,507 Won per month, which is about 1.7

times higher than WTP for the KEEI study. This WTP result for this study may seem to be significantly different from the result of KEEI study. However, the average monthly total expenditure per household at the time of KEEI study was 3,440,716 Won and this was increased to 5,909,521 Won at the time of this study which is also about 1.7 times higher. Therefore, WTP results for gas accidents of these two surveys can be considered as almost the same results. This assures our WTP survey results for gas accidents and nuclear severe accidents are reasonable, and the external cost of nuclear severe accidents were reasonably induced.

Table 3. Validation table for WTP of gas accident (per month)

	This study(A)	KEEI study (B)	A/B
WTP for prevention of gas accident	8,057 Won	4,702 Won	1.712464
Average total expenditure per household	5,909,521 Won	3,440,716 Won	1.717527

4. Conclusion

For the nuclear electricity generation, the problem of evaluating the external cost of nuclear severe accidents remains unresolved and controversial issues. Several recent studies have tried to integrate the risk aversion in the external costs of severe nuclear reactor accidents and several methods have been tested for this purpose, but no one has been considered acceptable.

In this study, the external cost of the nuclear severe accident was evaluated using the CVM to address the effect of risk aversion of the public. A WTP question for gas accidents was added in the questionnaire to be used for validation of the survey results.

The external cost evaluation result of the nuclear severe accident considering the risk aversion of the public was 12.03 Won/kWh. The WTP result for gas accidents in this study was compared with the precedent KEEI study result and was confirmed acceptable. This assure our WTP survey results for gas accidents and nuclear severe accidents are reasonable, and the external cost of nuclear severe accidents were reasonably induced.

REFERENCES

- [1] NEA, "Nuclear Electricity Generation : What are the External Costs?", 2003
- [2] ExternE, "Externalities of Energy", 1995
- [3] Eeckhoudt, et al., "Risk Aversion and the External Cost of a Nuclear Accident", Journal of Environmental Management, 2000, pp. 109-117
- [4] KEEI, "Social Cost-Benefit Analysis for Gas Safety Management", 1999