

A Study of the Social Effects in a Comparative Assessment among the Electricity Generating Systems

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INTRODUCTION

A comparative assessment among 7 electricity generating systems by considering their environmental impacts, risks, health effects, and social effects was studied[1] last year. The compared electricity generating systems are nuclear, coal, LNG, hydro, oil, wind, photo-voltaic (=solar) ones.

In last year's work[1], the social effects were handled by a public acceptance based on an aversion. However, in this paper, the social effects were also studied by a preference in view of the 'willingness to pay'(WTP).

With the new social effects study, a comparative analysis of the 7 electricity generation systems was performed in this paper.

DESCRIPTION OF THE ACTUAL WORK

It is necessary to use one common utility function to compare different concepts such as the social, environmental, and economic effects incurred by various electricity generation systems. In this study, a monetary value (= cost) is used for the common utility function.

2.1 Social Effects

It is assumed that the different social effects of various electricity generating systems could be represented by a public's acceptance, and a public's acceptance could be estimated in view of an aversion and preference. Thus, the 'public's acceptance cost' of Ref.[1] is the estimation of a public's acceptance in view of an aversion. Let's call it a 'public aversion cost'(PAC). The public's acceptance in view of a preference is the WTP. Let's call it a 'public preference cost'(PPC). In this paper, thus, a 'public's acceptance cost' is defined as below:

$$\text{'public's acceptance cost'} = \text{PAC} - \text{PPC} \quad (1)$$

WTP is estimated by three consecutive questionnaires. In the first questionnaire, the advantages and disadvantages of each energy sources is given before the questionnaire.

For example, the following questionnaire was used to estimate the WTP for nuclear power:

"Please check the advantages and disadvantages of nuclear power plants (NPPs) in the given table. If the electricity is generated by only NPPs, how much are you willing to pay for the electricity fare? (The current average fare is 88₩/Kwh)" Let's define WTP1 is the WTP estimated by the first questionnaire.

In the second questionnaire, the actual production cost of each electricity generating system is given first, and then the question "If the electricity is generated by only NPPs, how much are you willing to pay for the electricity fare?" is asked. WTP2 is defined as the WTP estimated by the second questionnaire.

In the third questionnaire, the actual external cost of each electricity generating system is given first, and then the question "If the electricity is generated by only NPPs, how much are you willing to pay for the electricity fare?" is asked. WTP3 is the WTP estimated by the third questionnaire.

Similarly, the WTP for the other energy sources are also estimated by the questionnaires.

The questionnaires were performed with 30 respondents. The results of the questionnaire are summarized in Table 1.

Table 1. WTP of the various electricity generating systems

	Nucl.	Coal	Oil	LNG	Hydro	Wind	Photo-voltaic
WTP1	72	70	81	84	84	82	108
WTP2	56	51	76	80	102	84	431
WTP3	91	83	110	78	112	112	300
PPC	-15	-20	1	-7	11	5	191

In Table 1, WTP1 of the various electricity generating systems shows that the difference between a high and low value is not severe. The meaning of 70, WTP1 of coal, is that the respondents of the questionnaire will pay only

70₩/kwh instead of 88₩/Kwh as the electricity fare is if only the coal power plants generate electricity.

As shown in WTP2 of Table 1, after the actual production cost of each electricity generating system is given, the respondents changed their WTP by considering the actual production cost. For example, since the actual production cost of Photo-voltaic system is 716₩/Kwh, the WTP of that source increased to 431₩/Kwh, and since that of NPPs is 40₩/Kwh, the WTP of NPPs dropped to 56₩/Kwh. Except the Hydro case where WTP2 increased more than the actual production cost, in the most case, WTP2 value locates between WTP and the production cost. Thus, WTP2 strongly depends on the actual production cost except strongly favorable or hate systems.

As shown in WTP3 of Table 1, after the external cost of each electricity generating system is given, the respondents changed their WTP by considering the environmental and health effects. For example, since a photo-voltaic system is unexpectedly harmful to the environment, the WTP of that source decreased to 300₩/Kwh, and since that of NPPs is not bad to the environment, the WTP of NPPs increased to 91₩/Kwh.

In Table 1, PPC is derived by the following equation:

$$PPC = (WTP1+WTP2+WTP3)/3 - 88 \quad (2)$$

In this study, the previous public aversion cost(PAC) was calculated again with increasing the number of respondents and the new assumptions such as the populations near the power plants. The new PAC is given in the Table 2. The detailed method to derive the PAC was described in Ref.[1].

2.2 Economic, Environmental and health effects

The economic effects can be expressed by a production cost. The production costs incurred by the different electricity generating systems are well derived in Ref. [2]. The environmental and health effects can be represented by the external cost. The external cost induced by the different electricity generating systems is calculated and detailed well in Ref. [3].

RESULTS

Therefore, the summation of the production, external, and public acceptance cost will be the total cost incurred by an electricity generating system. The public's acceptance cost is derived by the Eq.(1). The total costs of the various electricity generating systems are shown in Table 3.

Table 2. Public aversion cost of the various electricity generating systems

	Nuclear	Coal	Oil	LNG	Hydro	Wind	Photo-voltaic
Compensation (x10,000 Won)	268-820	416-946	325-856	239-735	48-580	57-523	11-375
Population (x10,000)	20	10	10	10	1	0.1	0.1
Capacity (Kw)	1,000 x 10 ⁴ x 4 unit	50 x 10 ⁴ x 4 unit	35 x 10 ⁴ x 4 unit	30 x 10 ⁴ x 2 unit	20 x 10 ⁴	1.65x10 ³ x24 unit	3000
Availability (%)	93	88	85	40	13	27	25
Reference Plant	UCN 3,4,5,6	Taeam 1,2,3,4	Pyung Taek 1,2,3,4	West Incheon Combined Cycle	Soyang -kang	Young-Duck	Young-Duck
PAC(₩/Kwh)	30-37	40-49	53-64	105-128	123-150	25-31	256-313

Table 3. The total costs of the various electricity generating systems

	Nucl.	Coal	Oil	LNG	Hydro	Wind	Photo-voltaic
Production Cost	40-41	42-43	76-80	77-119	71-83	108-117	716-832
External Cost*	3-9	26-195	39-143	13-52	1-13	0.7-3	7-9
Public's Acceptance Cost	45-52	60-69	52-63	112-135	139-112	20-26	64-121
Total Cost	88-102	128-307	167-286	202-306	184-235	129-147	787-962

* based on EC average values [3]

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