

A Pilot Study on Comparative Assessment of Electricity Generating Systems Using Monetary Value

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1. Introduction

Recently, many variables which affect the cost of electricity generating systems are drastically changing. For examples, the price of crude oil soared above 70 dollars a barrel and it will be continuously going up.

Kyoto Protocol, an international agreement signed by 141 countries that promise to reduce greenhouse gases, finally entered into force on February 16, 2005. A total of 39 countries are required to reduce their emissions of greenhouse gases, including carbon dioxide, methane and nitrous oxide, to 5.2 percent below the 1990 levels during 2008-2012.

Also, many researches and government support are concentrated on the renewable energy. In Korea, the portion of renewable energy in the electricity generation will be increased up to 7% in 2010. Therefore, a comparative assessment among electricity generating systems by considering the environmental impacts, risks, health effects, and social effects is required to establish the national energy and power systems planning systematically and scientifically.

Up to now, several papers for data collection and analysis of the environmental impacts, risks, and health effects for various electricity generation systems in Korea were published. However, they were not the comparative assessment covering all impacts and effects but just a partial assessment (e.g., environmental impacts assessment only)[1-2], or not covering all generating systems such as nuclear, coal, LNG, hydro, oil, wind, photo-voltaic (=solar) but covering partial ones (e.g., nuclear, coal, LNG, and wind only)[2]. Although Ref. [3] deals all electricity generating systems, and all impacts such as economic, environmental, health, and social impacts, it used too much subjective opinion by using pairwise comparison questionnaire to know the relative importance among the economic, environmental, health, and social effects.

However, if economic, environmental, health, and social effects of the various electricity generation systems could be calculated by monetary value, the comparative assessment of the various electricity generation systems would be objectively performed.

The objective of this paper is to establish an objective framework for the comparative analysis of the environmental impacts, risks, health, and social effects for the various electricity generation systems

2. Methods and Results

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

2.1 Social Effects

It is assumed that the different social effects of the various electricity generating systems could be represented by the public acceptance. That is, if a electricity generating system has a bad public acceptance, then that system would pay a social cost to get a better public acceptance and to be built. Let's call the social cost as 'public acceptance cost'. It is assumed that the public acceptance cost can be estimated by a questionnaire. For example, the following questionnaire would be used to estimate the public acceptance cost for nuclear:

"If nuclear power plants (NPPs) will be built next to your home, you would oppose to the plan. However, if some compensation money would be paid to you every year, you may accept the plan. How much would be acceptable to you?"

The answers of the questionnaire are summarized in Table 1. In Table 1, the annual compensation money for NPPs is 600×10^4 won. If the other factors are given as shown in Table 1, then the public acceptance cost of NPPs can be calculated as below:

Since,

$$\begin{aligned} & [\text{annual amount of electricity generated by NPPs}] \\ & = 1000 \times 10^4 \text{ Kw} \times 2 \text{ unit} \times 365 \times 24 \times 93\% \\ & = 16.3 \text{ billion Kw} \end{aligned}$$

$$[\text{annual compensation cost}]$$

$$= 600 \times 10^4 \text{ Won} \times 40 \times 10^4 \text{ persons}$$

Thus,

$$\begin{aligned} & [\text{public acceptance cost of NPPs}] \\ & = [\text{annual compensation cost}] / [\text{annual amount of electricity generated by NPPs}] \\ & = 1.47 \text{ (€/Kwh)} \end{aligned}$$

The other public acceptance costs incurred by the other electricity generating systems are also given in Table 1. In Table 1, it is assumed that the population around

NPPs is 8 times as much as that around coal power plants by considering violent anti-nuclear protests of residents around NPPs in Korea. The availability was referred from Ref. [6] and other news papers.

	Nuclear	Coal	LNG	Hydro	Wind	Photo-voltaics
Compensation (x10,000 Won)	600	200	300	50	10	5
Population (x10,000)	40	5	5	10	0.1	1
Capacity (Kw)	1,000 x 10 ⁴ x 2 unit	50 x 10 ⁴ x 2 unit	30 x 10 ⁴ x 2 unit	20 x 10 ⁴	600 x 10	3000
Availability (%)	93	88	40	13	27	25
Reference Plant	UCN 5,6	Tae'an 3,4	West Incheon Combined Cycle	Soyang-kang	Cheju Kuchoa	Young-Duck
Public Acceptance Cost (€ /Kwh)	1.47	1.3	7.1	22.0	0.7	7.6

Table 1. Public acceptance cost of the various electricity generating systems

2.2 Economic, Environmental and health effects

The economic effects can be expressed by production cost. The production costs incurred by the different electricity generating systems are well derived in Ref. [4]. The environmental and health effects can be represented by the external cost. The external cost induced by the different electricity generating systems is well calculated in Ref. [5]. Therefore, the summation of the production, external, and public acceptance cost will be the total cost incurred by an electricity generating system. The total costs of the various electricity generating systems are shown in Table 2, and Figure 1.

	Nuclear	Coal	LNG	Hydro	Wind	Photo-voltaics
Production Cost*	3	3	3.3	13	9	64
External Cost**	0.39	5.69	1.79	0.43	0.15	0.6
Public Acceptance Cost	1.47	1.3	7.1	22.0	0.7	7.6
Total Cost	4.86	9.99	12.19	35.43	9.85	72.2

* based on German study [4]

** based on EC average values [5]

Table 2. The total cost of the various electricity generating systems

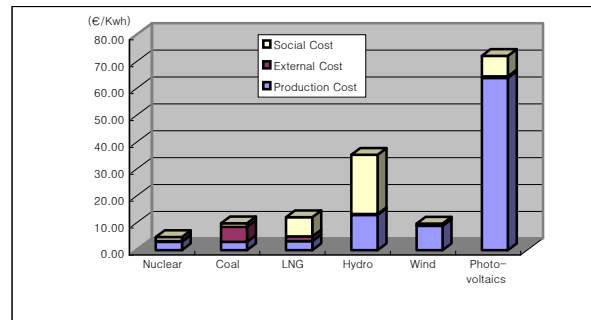


Figure 1. The total cost of the various electricity generating systems

3. Conclusion

Since the total cost incurred by NPPs is the lowest, NPPs are the best power plants from the economic, health, environmental, and social effects point of view. The production cost and external cost shown in Table 2 was not based on the studies reflecting Korean situation since the studies covering all affecting factors and all generating systems have not yet been completed in Korea. A framework for a simple and objective comparative assessment of electricity generating systems using monetary value is suggested, and public acceptance cost representing social effects is introduced in this study.

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