Comparative Study on the Power Generation Options in Korea using Multi Criteria Decision Analysis

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1. Introduction

The electric utility sector is of central importance for the economic growth and social development. While numerous social and economic benefits arise from electricity production, it can also have impacts, which may not be fully agreed to the concept of various dimensions.

This paper provides a comparative study on several kinds of power generation options in Korea using Multi-Criteria Decision Analysis (MCDA) method [1]. In the analysis using MCDA, four factors are used; economical, environmental, social and security-related. The MCDA-based technology-specific scores are useful comparative indicators. This evaluation covers selected current coal, nuclear and renewable energies (wind and photo voltaic technologies) in Korea.

2. Method and Analysis

2.1 Multi-Criteria Decision Analysis

MCDA provides a framework that allows the often conflicting evaluation criteria to be addressed simultaneously. Full-scale implementation of such analysis requires the establishment of systematic and transparent process with interactions between analysts and decision makers.

Under the expert-based decision system, there is one well-defined objective and one unique value system. Decision is made by expert considering one specific objective. There is one actor and one objective in this model.

Under the MCDA-based decision system, one decision-maker at the top of hierarchy makes decision considering several kinds of objectives related to his organization. There is one actor and multi-objectives in this model.

After doing MCDA-based analysis by one decision maker, a negotiation process might be needed. Decision makers with different objectives, different value systems take part in decision-making process through negotiation.

In this study, we made MCDA-based decision in the power generation sector under Korean circumstance. We chose several kinds of criteria (objectives) and gave weightings on them. For applying this kind of analysis to national decision making, in-depth negotiation process has to be performed.

2.2 Criteria and indicators

Criteria and indicators employed in this study are listed in Table 1.

Table 1. Criteria and indicators of the analysis

	Impact Area (weight)	Indicator (weight)	Unit
Economical	Financial Requirement (70)	Production cost(75)	Won/kWh
		Fuel price increase sensitivity(25)	Factor
	Resources(30)	Availability(50)	%
		Geo-political factor(20)	Relative scale
		Peak load response(30)	Relative scale
Environmental	Global warming	CO^2equivalent(40)	Tons/GWh
	Regional environmental impact	Change in unprotected ecosystem area(20)	Km^2/GWh
	Non-pollutant effect	Land use(10)	m^2/GWh
	Severe accident	Fatalities(15)	Fatalities/GWh
	Total waste	Total weight(15)	tons/GWh
Social	Public Acceptance	Public against (35)	Relative scale
	Human health impacts	Mortality(35)	Years of life lost /GWh
	Critical waste confinement	Necessary confinement time(15)	Thousand years
	Risk aversion	Maximum credible number of fatalities per accident(10)	Max. fatalities /accident
	Proliferation	Potential (5)	Relative scale
Security	Fuel import	Domestic supply (20)	%
	Fuel stockpile	Domestic supply (20)	%
	Technology and component import	Domestic supply (30)	%
	Market share	Portion of market Share (30)	%

3 Results

We studied for the comparative study on the energy technology evaluation and we got some data from references [1-5]. Some of the data from the UCTE[1] were used [1 and 2]. From the results, we put the scores and then drew score graphs using linear interpolation method from 50 to 100. The alternative which did best on a particular criterion was assigned a score of 100 the one which did least well a score of 50; based on linear interpolation all other alternatives were given intermediate scores which reflected their performance relative to these two end points. A single overall value was obtained for each alternative by summing the weighted scores for all criteria. Ranking of the options was then established on the basis of these scores. We

[1] Union for the Co-ordination of Transmission of Electricity.

also did the normalization from 0 to 100 instead of 50 to 100, but there was no change of the rankings.

The weights can be obtained from stakeholders and various weighting schemes can be assigned to accommodate a range of their interests. The sensitivity to the weighting schemes has been investigated.

Figure 1 depicts the result of the analysis with the full set of data using the four dimensions with the equal weightings. Figure 2 shows the social centered[2] data which represent that nuclear is underestimated than full set data. Figure 2 illustrates the sensitivity to the social criteria.

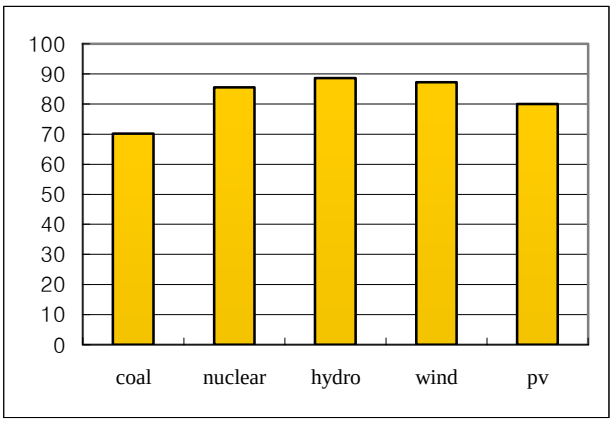

Figure 1. Full set of data result

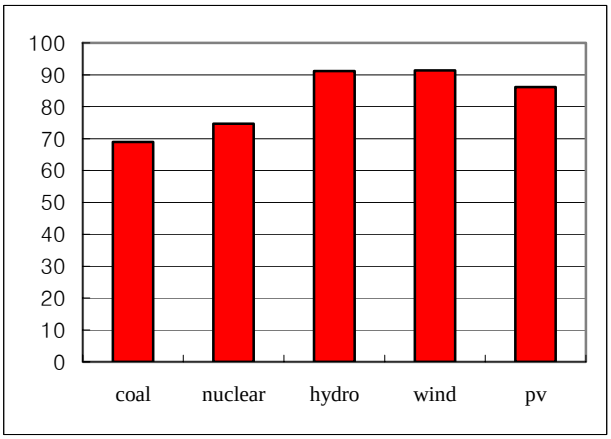

Figure 2. Social centered data result.

Table 2. Full set of the results

Option	Social	Security	Economical	Environmental
Coal	68.1	74.1	89.0	50.0
Nuclear	67.5	85.9	91.5	98.9
Hydro	92.9	78.3	85.5	95.2
Wind	94.2	75.0	82.5	97.9
PV	90.2	79.0	60.3	90.5

[2] Social centered means that social dimension is given a weight of 70%, while environmental, economic and security dimensions have a weight of 10%; other cases are also conducted.

In Table 2, the scores of each option in each criterion are shown. By averaging scores from four criteria, the score of each option can be obtained. In Figure 1, the weightings on each criterion are given equally. If you want to see the sensitivity to a particular criterion, you can give less weighting or no weighting on the particular criterion.

Considering four criteria together, we achieved Figure 1. Hydro, wind and nuclear are leading options followed by photo-voltaic and coal options. But, without considering social criterion, hydro, wind and photo-voltaic options are leading options followed by nuclear and coal.

In terms of social or public acceptance, nuclear and photo-voltaic give to and receive from society controversial impacts.

4. Conclusion

In this paper, we conducted a comparative analysis about the options for power generation in Korea. As seen above, nuclear energy is too underestimated in view of the social factor. Therefore, we should have to concentrate on increasing the social score, especially “public acceptance (PA)”, through giving understanding of economical, environmental and energy-security related strength of nuclear power. In the future, with the enhanced understanding of positive aspect of nuclear option, social strength of nuclear option can be enhanced.

Negotiation process beyond MCDA study can be pursued as a further study of this work.

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