The effect of fossil fuel prices to electric generation mix

Seung-Su Kim, Kee Hwan Moon
Economic Analysis Section, Korea Atomic Energy Research Institute
1045 Daedeok Daero, Yuseong Gu, Daejeon, Korea, sskim5@kaeri.re.kr

1. Introduction

The rapid economic growth in the newly rising developing countries like China and India provoked the competition for resource security worldwide. These resources include crude oil, coal, natural gas, uranium with other mineral materials. Crude oil was especially in the center of this competition. In the meantime, the cost for electric generation in Korea depends heavily on the prices of fuels such as coal and LNG since almost fuels for generation have to be imported from abroad.

Accordingly the rising of fossil fuel prices lead directly to the increase of the average generation cost in Korea. This also requires the change of the rational electric system mix which is mainly determined by the lifetime costs of each generation technology.

The objective of this study is to analyze the direction or range of change in electric mix influenced by the changes of fossil fuel prices. In the following sections, firstly we will summarize the forecasts for fossil fuel prices from overseas expert agencies, followed by the choice of LDC(Load Duration Curve) to be used and the calculation of generation costs by each technology.

2. Methodology

For the quick and easy solution for the determination of electric mix instead of using a complex computer model, the screening curve method is frequently used that is also adopted in this analysis. This method is one that determines the most economic generation mix through the connection of the LDC curve in the electric demand side and the comparative generation costs by electric technology in the electric supply side. However the weakness of the screening curve method is difficult to consider the effects of exact operational simulation in the process of generation that is related to the technical and O&M factors while its strength is the simplicity and the usefulness for political decision. None the less this method is assessed to be quite useful in policy making.

As for LDC, it is assumed in this study that a LDC pattern in 2007 is continued to be same until 2020. This is mainly due to the fact that electric demand pattern will not be easily changed unless the system of electric tariff would be changed largely. The input data for the fixed cost calculation of screening curve are based on the basic assumptions for “The 3th Basic Plan of Long-Term Electricity Supply and Demand” in Korea.

The total annual cost by generating technology to the capacity factor change should be performed before the adoption of screening curve method. Then the minimum cost generation options by the capacity factor section are chosen with the corresponding capacity factor ranges.

In the last stage, the capacity factor sections chosen should be matched to the correspondent LDC in order to produce the necessary capacity size by each generation technology.

3. Results

The main fossil fuels for electric generation in Korea are uranium, bituminous coal, LNG. Nuclear generation occupies about 35.5% of share while the generation for coal and LNG do 38.4% and 19.4% respectively in 2007.

The following table shows the perspective for the main fossil fuel prices in the future, provided by the foreign forecasting agencies.

Table 1. Perspective for fossil fuel prices(constant price in 2007)

Fuels	Unit	Year 2007	Year 2015	Year 2020
Uranium	$/lb U3O8	46	46	46
Coal	$/ton	79.4	68.28	61.84
LNG	$/ton (won/Gcal)	511.075 (39,417)	646.935 (49,895)	642.742 (49,571)
Oil	$/bbl	72.2	72.52	72.05

For fuel prices in 2007 in the above table 1, those for uranium and LNG mean the average import prices, the overseas spot price for coal, and the average value of forecasts by EIA(Energy Information Administration in USA), PIRA(Petroleum Industry Research Associates), and CERA(Cambridge Energy Research Associates in USA) for oil.

As for the future perspective of fuel prices, we can find in table 1 that uranium prices are the same as in 2007 while coal prices are slightly continuously decreasing and LNG prices are fluctuating a little with the final increase.

The screening curve for 2020 using the above assumptions is shown in figure 1. As we can see it through the graph, the rational capacity shares of coal, LNG, nuclear power are presented to be about 17.5%, 12.5%, and 70% respectively. These shares seem to be quite different from the present plant mix which is 24.4% of nuclear and about 30% of coal capacities. In the meantime, we considered as the alternative of analysis only the most prevalent type of power plants,

which are coal 500 and nuclear1000 instead of coal800 and nuclear1400, in order to stand the more conservative point of view. The above result mainly seems to be caused from the relatively high coal price compared to nuclear fuel cost in the future. In addition to that, it means that current nuclear share in electric system should be increased much more in order to reflect the rationality in economic point of view.

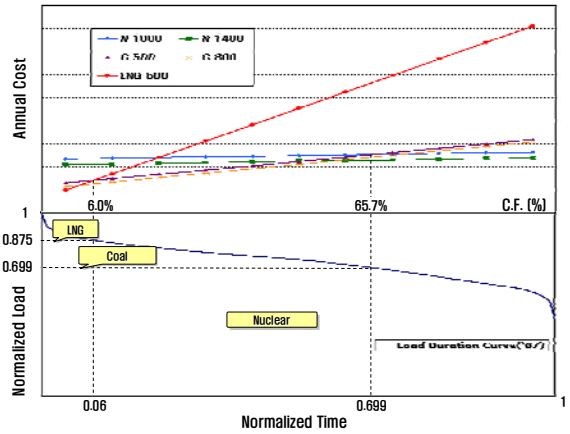

Figure 1 Economic electric mix in 2020

Table 2. Sensitivity analysis for fuel price change

		Fuel prices	Nuclear	Coal	LNG
Basic Scenario	2007	▶ Uranium: 46 $/U3O8 lb ▶ Coal: 79.4$/ton	75%	10.5%	14.5%
	2020	▶ Uranium: 46$/U3O8 lb ▶ Coal: 61.8$/ton	70%	17.5%	12.5%
Sensitivity	2020	▶ Uranium: 46$/U3O8 lb ▶ Coal: 93$/ton	76.7%	9.9%	13.4%
	2020	▶ Uranium: 77.3$/U3O8 lb ▶ Coal: 61.8$/ton	68.3%	19.2%	12.5%

In the above sensitivity analysis for uranium and coal prices in 2020, it is found that coal price is very influential to the determination of electric mix compared to nuclear fuel price. This is due to the fact that the share of fuel cost to total cost in nuclear power is much lower than that in coal power plant. From this result it is expected that nuclear power is much superior to coal power in viewpoint of energy security.

4. Conclusion

The most issuing problem in energy resource environment is the variability of fossil fuel prices such as oil, coal, LNG, uranium and etc. Especially the electric sector in Korea is natural to be sensitive to this situation because of the high overseas energy dependency and the rapid increase of electricity demand.

For the rational and economic electric system plan, policy makers should consider much more nuclear power addition than that in the present electric system composition. When considering the future uncertainty in energy resource market, nuclear power will certain to be more favorable option than any other fossil power plants in the future. In addition, in line with the abatement of green house gas emission worldwide, nuclear energy with no CO2 emission is an absolutely nature option for Korean future.

REFERENCES

[1] OPEC, World Oil Outlook, 2007
[2] PIRA, Retainer Client Seminar, 2007
[3] PIRA, Scenario Planning Quarterly Updates 2Q2008, 2008.5
[4] “Economic analysis of nuclear energy”, Korea Atomic Energy Research Institute, 2008.