Transactions of the Korean Nuclear Society Autumn Meeting
Gyeongju, Korea, October 24-25, 2013

Generation Mix Study Focusing on Nuclear Power by Practical Peak Forecast

Jung-Ho Shin*, Myung-Sub Roh
KEPCO International Nuclear Graduate School, 1456-1 Shinam-Ri, Seosaeng-Mueon, Ulju-Gun,Ulsan
*Corresponding author : *billiantt@gmail.com*

1. Introduction

The Basic Plan for Long-term Electricity Supply and Demand (BPE) is prepared and announced biennially by the Minister of Knowledge Economy pursuant to Article 25 of the Electricity Business Act [1]. Since the electric power sector restructuring of 2001, the basic plan has been prepared 6 times up to the present. The common phenomenon among previous 5 BPE is that the peak demand forecast has been underestimated. The excessive underestimation can lead to a range of problem; expansion of LNG plant requiring short construction period, the following increase of electricity price, low reserve margin and inefficient configuration of power source.

With regard to nuclear power, the share of the stable and economic base load plant, nuclear power, can reduce under the optimum level. Amongst varied factors which contribute to the underestimate, immoderate target for demand side management (DSM) including double deduction of the constraint amount by DSM from peak demand forecast is one of the causes [2].

The hypothesis in this study is that the better optimum generation mix including the adequate share of nuclear power can be obtained under the condition of the peak demand forecast without deduction of DSM target because this forecast is closer to the actual peak demand. In this study, the hypothesis is verified with comparison between peak demand forecast before (or after) DSM target application and the actual peak demand in the 3rd through 5th BPE from 2006 to 2010. Furthermore, this research compares and analyzes several generation mix in 2027 focusing on the nuclear power by a few conditions using the WASP-IV program on the basis of the 6th BPE in 2013.

2. WASP-IV modeling and result

2.1 Comparative analysis on the peak demand forecast and actual peak demand

The peak demand forecast between 2006 and 2012 in the 3rd BPE (2006.12) was estimated in the range between 58,994MW and 72,759MW. The forecast was calculated with DSM reflected [3]. The actual peak demand over the same period, however, exceeded the forecast. The forecast without DSM reflected showed rather closer figures to the actual peak demand than the forecast with DSM reflected. These findings mentioned above are presented in Fig. 1.

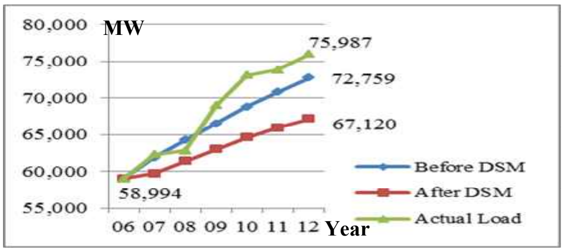


Fig. 1. Comparison between Peak Demand Forecasts and Actual Peak demand (The 3rd BPE) [1] [3]

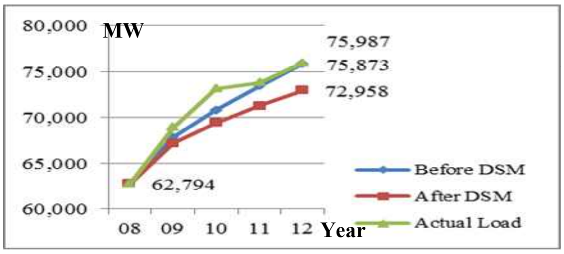


Fig. 2. Comparison between Peak Demand Forecasts and Actual Peak demand (The 4th BPE) [1] [4]

The similar result can be seen the following 2 BPEs. But due to the paper restriction of 2 pages, the line graph on the only 4th BPE is illustrated in Fig. 2.

One of the reason why the forecast with DSM reflected was underestimated for its actual peak load is double deduction of the DSM figure plus excessive DSM target. That is, the actual peak demand in the past is utilized to forecast the future peak demand and this already includes the DSM reflection. In addition to this, the final peak demand forecast is determined after the DSM target is deducted. Consequently the final forecast is a result from double reflection of DSM influence.

2.2 WASP-IV software

WASP-IV is a planning software which is designed to find the economically optimal generation expansion policy for an electric utility system within user-specified constraints. It utilizes probabilistic estimation of system, production costs, reliability, linear programming technique for determining optimal dispatch policy satisfying exogenous constraints on environment, fuel availability and electricity generation by some plants, and the dynamic method of optimization for comparing the costs of alternative system expansion policies.

2.3 WASP-IV modeling for the 6th BPE

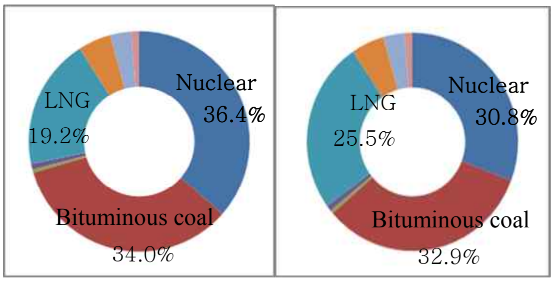
Based on the information from the 6th BPE, input data for 6 modules in WASP-IV were prepared. Especially, for comparison generation mix between peak demand forecast after DSM and peak demand forecast before DSM, peak load data for Loadsys module were developed in pair. The extract of each peak demand forecast is shown in Table 1. And we assumed that deficient capacity was compensated by constructing the LNG plant with short construction period when the generation expansion was planned based on the forecast after DSM but the forecast before DSM was realized as an actual peak demand.

Table I: Extract of DSM & Peak demand forecast (6th BPE)

Year	DSM	Peak Demand	
	Target (MW)	Target (MW)	
		Before DSM	After DSM
2015	1,981	84,648	82,677
2020	6,889	102,205	95,316
2025	15,022	120,078	105,056
2027	15,854	126,740	110,886

2.4 Result from WASP-IV run

The 2 pie charts in Fig. 3 illustrate the distribution rate of generation resources from WASP-IV run by each peak demand forecast.



Distribution on the forecast without DSM reflected

Distribution on the forecast with DSM reflected and compensation by LNG

Fig. 3. Proportion of Generation Sources by Peak Forecast between without and with DSM reflection

It can be noted that the generation mix without DSM consideration in 2027 is computed that nuclear power constitute 36.4% (with 56,016MW of installed capacity) out of the total generation capacity, 34% (with 52,309MW) for bituminous coal and 19.2% (with 29,548MW) for LNG respectively. The objective function which is the total cost of the expansion plan was estimated at around 334bil$.

On the contrary, when the expansion plan is developed based on the peak demand forecast with DSM reflected and the peak demand without DSM reflected occurs in reality, then the shortage is compensated by the construction of the LNG plant with short construction period. So the share of the nuclear, one of the base load plants, drops to 30.8% (with 44,916MW of installed capacity) whereas the share of LNG, the major peak load plant, skyrockets to 25.5%. Its objective function is calculated at around 354bil$.

3. Conclusions

According to the comparative analysis on the peak demand forecast and actual peak demand from 2006 to 2010, the peak demand forecasts without the deduction of the DSM target is closer to the actual peak demand than the peak demand forecasts considering the DSM target in the 3rd, 4th, 5th entirely. In addition, the generation mix until 2027 is examined by the WASP-IV. As a result of the program run, when considering the peak demand forecast without DSM reflection, since the base load plants including nuclear power take up adequate proportion, stable and economic supply of electricity can be achieved.

On the contrary, in case of planning based on the peak demand forecast with DSM reflected and then compensating the shortage by constructing LNG plant with short construction period, double deduction of DSM reflection can lead to improper configuration of generation resources, enormous additional cost (20bil$ in this study) and the following price increase.

So as to achieve the economic feasibility with the proper share of the base load plant such as nuclear power, it can be seen that the generation mix plan should be based on the peak demand forecast before DSM target.

4. Limitation of this study

In the 6th BPE, macro model is introduced in addition to the existing micro model (used in WASP-IV) to improve the forecast power. In macro model, power consumption is predicted reflecting future economic growth outlook, power consumption trend, and power demand growth pattern of major developed countries [1].

Besides, for nuclear power plant, reflection of new supplies is postponed until the 2nd Master Plan for National Energy is finalized considering public acceptance level after the Fukushima Daiichi accident [1]. Since this paper does not consider the macro model and another constraint on the expansion of the nuclear power plant by the government policy, the result from this study needs more research considering those factors. This study remains these issues as the further study.

REFERENCES

[1] The 6th Basic Plan for Long-term Electricity Supply and Demand (2013~2027), Ministry of Knowledge Economy, p. 1, 17, 26, 5, 19, 50, 2013.

[2] Roh Dong-Seok, Mini-Max Regret Analysis for Electricity Demand-Supply Planning, The Division of Energy Systems Research, Graduate School of Ajou University, p.20-21, 2010.

[3] The 3rd Basic Plan for Long-term Electricity Supply and Demand (2006~2020), Ministry of Commerce, Industry and Energy, p. 14, 57, 2006

[4] The 4th Basic Plan for Long-term Electricity Supply and Demand (2008~2022), Ministry of Knowledge Economy, p. 63, 2008