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Key Factors for Nuclear Being Economic after Fukushima

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1. Introduction

It is hard to overstate the importance of electricity to the standard of living and the quality of life in a country. Electricity demand grows with population and with the changing nature, level and composition of economic and social activity. Civilization, industrialization and urbanization are, of course, key factors.

It, historically, has shown that each major nuclear accident has caused a re-examination of the risk of nuclear power leading to more stringent safety requirement and higher costs. The Fukushima accident and its likely impact on future nuclear power development are difficult to foresee. The accident was a tragedy for the people affected and seriously undermined public confidence in the safety of nuclear power. A number of countries announced reviews of their programs, some took steps toward phasing out nuclear power entirely, and others reemphasized their expansion plans.

The Korean nuclear community is carry out many ambitious projects for last three decades continuously and facing the another challenges relating to the future nuclear power economics and difficulty in financing new investment. In order to meet the above economic objective, it is strongly recommended that great emphasis should be placed on maintaining the nuclear economics without jeopardizing safety such as design simplification, standardization, shortening of construction period, increased availability, etc[1].

2. Nuclear Power Projection

The estimates of future nuclear generating capacity presented in Table 1 which are derived by IAEA from a country by country bottom up approach[2]. Regardless of some uncertainties, the continued growth in future projections suggest that the reason for increased interest in nuclear power before the accident have not changed yet: a) energy and electricity demand growth and economic development; b) concerns continue to persist about security of energy supply and high and volatile fossil fuel prices; and c) the quest for stable electricity generating costs is still major incentive for public and private sector interest in nuclear power.

Table 1. Estimate of Nuclear Generating Capacity

Country group	2010 GW(e)	2020(a) GW(e)	2030(a) GW(e)	2050(a)(b) GW(e)
North America	113.8	119 124	111 149	120 200
Latin America	4.1	6.4 6.4	9 18	15 60
Western Europe	122.9	93 126	83 141	60 170
Eastern Europe	47.4	66 80	82 108	80 140
Africa	1.8	1.8 1.8	5 16	10 48
Middle & South Asia	4.6	13 22	30 53	50 140
Sou. East Asia & Pacific	-	- -	0 6	5 20
Far East	80.6	130 164	180 255	220 450
World Total	375.3	429 525	501 746	560 1228

(a) Estimates take into account the retirement of older units
(b) Figures for arrhythmic average between low & high estimates

3. Analysis and Review of Korean APR Economics

The scope and contents of this analysis covers the calculation of the total generating cost of APR by splitting into following categories:

- Capital costs
- O&M costs
- Fuel costs
- Decommissioning costs

This analysis also includes the effects of uncertainty on each variable that affects the result. A series of sensitivity analyses for various key assumptions and major cost contributors were included in the analysis and the 1,000 MWe classes Korean Standardized Nuclear Power Plant (KSNP) was chosen for comparison data in the assessment.

3.1 Analysis Method

The analysis was performed using a Minimum Revenue Requirements Method (MRRM), where the revenue requirement is the least cost that must be collected from customers to compensate a utility for all expenditures.

In performing the analysis, a number of basic assumptions were made, as summarized in Table 1. The present worth revenue requirement is then levelized to reflect the average lifetime annual generation cost discounted to the reference year[3].

Table 2. Basic Assumptions

Items	Description
Economic Operational Life	30 years
Book Depreciation Method	Straight Line Method
Discount Rate	8 %
Interest Rate	8 %
Capacity Factor	80 %
Construction Style	Twin units
Construction Period	48 months(Nth unit)
Electric Power Capacity	1400 MWe / unit

3.2 Result and Discussion

As shown in Table 3, the APR1400 generating cost from twin units is 35.42 mills/kWh as compared to 42.90 mills/kWh of 1,000MWe KSNP. It is estimated that APR1400 has about 17.4 % reduction in generating cost compared to 1000MWe KSNP. It shows that its economic competitiveness largely can be achieved through the capital and Operation and Maintenance (O&M) costs reduction.

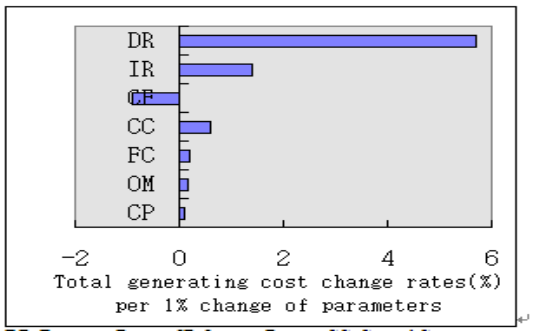
Table 3. Analysis Results

Items	KNGR (1,400MW * 2)	KSNP (1,000MW * 2)
Capital Cost($/kW)	1,555	1,979
Generating Costs (mills/ kWh)	35.42	42.90
- Fixed Charges	21.51	27.52
- O&M Costs	6.25	8.02
- Fuel Costs	6.85	6.43
- Decomm. Costs	0.81	0.93
Reduction Rate	17.4 %	reference

3.3 Sensitivity Analysis

A number of sensitivity analyses were performed to evaluate the effect of changing the critical input parameters from the basic assumptions. These sensitivity analyses included various assumptions for discount rate, capacity factor, capital cost, operation and maintenance cost, fuel cost, and construction time, etc.

The most sensitive parameter on generating cost is the discount rate, and the other parameters of the interest rate, capacity factor, capital cost, fuel cost, O&M cost, and construction period follow the rank as seen in Figure 1.



DR: Discount Rate, IR: Interest Rate, CC: Capital Cost
CF: Capacity Factor, FC: Fuel Cost, OM: O&M Cost
CP: Construction Period

Figure 1. Order of Importance

4. Key Economic Factors of NPP

Since discount rate and interest rate largely depend on the social financing circumstances, it could generally be said that capital cost and capacity factor are the major influential parameters on the generating cost. Thus, it is natural to say that competitiveness of APR depends upon making effort to reduce the capital cost and to increase the average annual capacity factor. The areas of improving the competitiveness of APR series are listed below.

- Unit Size : Economy of Scale
- Multi-units (twin) Plant construction
- Project Management and Control Upgrade
- Design Standardization and Completion
- Design Simplification
- Early Regulation and Licensing Interaction
- Shortening the Construction Period
- O & M Cost Reduction
- Decommissioning & Rad-waste management

REFERENCES

[1] KRC-92N-J11, Economic Evaluation of the Advanced Light Water Reactors, book 5, Research Report, Dec. 1994, KEPRI.

[2] Energy, Electricity and Nuclear Power Estimates for the Period up to 2050, Reference Data Series No.1, 2011 Edition, IAEA.

[3] K. Y. Yoo and H. K. Ha, Economic Assessment of KNGR's Conceptual Design, pp144-154, SFEN/ENS Proceedings, TOPNUX '96, 1996, ENS.