Prospects for the Competitive Export Price of SMART

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1. Introduction

SMART is an integral type pressurized water reactor with a thermal capacity of 330MW. Its design development is in the final stage preparing getting a design certificate. SMART has been developed by KAERI for the purpose of exporting it. The objective of this study is to estimate the probable price range of SMART in the exporting market. The estimation of competitive exporting price of SMART in advance is believed to be helpful in the establishment of the development strategy of SMART. Exporting price of SMART in this study means the construction cost of it. It is because the construction cost is a decisive factor determining the exporting price of SMART.

2. Methods

In this section the methodology is described. The estimation of the exporting price of SMART has sometimes been addressed based on the estimated construction cost with a margin added. However, this study tried to estimate it from the view point of the importing countries. In other words, we are trying to estimate the price level importers are willing to pay when importing SMART. In importing countries, SMART is assumed to be competitive with a CCGT (Combined Cycle Gas Turbine). This study focused on the estimation of the construction cost of SMART, which makes the levelized generation costs between SMART and CCGT equal.

The description above can be transformed into equation (1).

$$\frac{TC_{SMART} \times CRF(r,n)}{AG_{SMART}} + Fuel_{SMART} + O\&M_{SMART} = LGC_{ccgt} \quad (1)$$

Here, TC_{SMART} is the construction cost (Won) of SMART, CRF is a capital recovery factor, r is the discount rate (%), n is the lifetime of the plant (year), AG_{SMART} is the annual power generation (kWh), $FUEL_{SMART}$ is the fuel cost (Won/kWh), $O\&M_{SMART}$ is the operation and maintenance cost (Won/kWh) of SMART and LGC_{CCGT} is the levelzed generation cost of CCGT.

The left-hand side of equation (1) is the levelized generation cost of SMART, while the right-hand is the levelized generation cost of CCGT.

Equation (1) can be rearranged resulting in equation (2).

$$TC_{SMART} = \frac{(LGC_{ccgt} - Fuel_{SMART} - O\&M_{SMART}) \times AG_{SMART}}{CRF(r,n)} \quad (2)$$

It is TC_{SMART} in equation (2) that is the exporting price of SMART. TC_{SMART} can be interpreted as the construction cost of SMART, which makes the levelized generation costs between both technologies equal.

3. Preparation of the Input Parameters

In this section, estimations are conducted for each parameter placed in the right hand side of equation (2).

We need the input data necessary for the calculation of the levelized generation cost of CCGT of the potential importers of SMART. For the sake of convenience, we relied on the general data in the international market. We referred to the publication [1] from IEA/NEA to obtain them.

3.1 Overnight Cost

IEA/NEA (2010) [1] provides us with median value of the overnight costs of CCGT obtained from its member states. The overnight cost of CCGT is 1,069 ($/kW) for the power scale of 480MWe. Since the power scale of SMART is 100MWe, the overnight cost needs to be adjusted for the same power scale of 100MWe using the scaling factor.

The adjustment of the overnight cost is made using equation (3).

$$\text{Overnight cost of } CCGT\,(100MW) = \text{overnight cost of } CCGT\,(480MW) \times \left(\frac{480\,MW}{100\,MW}\right) \times \left(\frac{100\,MW}{480\,MW}\right)^{0.55} \quad (3)$$

Here, 0.55 is the scaling factor.

Finally, the overnight cost of CCGT (100MWe) is estimated to be 2,165 ($/kW).

3.2 Operation and Maintenance Cost

The median value of the operation and maintenance cost of CCGT is 4.48 ($/MWh). Based on this value, adjustment was made taking into consideration the diseconomy of scale as it was made in the overnight cost. As a result, the operation and maintenance cost of CCGT is estimated to be 9.07 ($/MWh).

3.3 Natural Gas Price

The median value of the natural gas price is 10.23 ($/MMBtu). Sensitivity values are introduced to reflect uncertainties on the natural gas prices. It is noted that heat efficiency used in this study is 57% in terms of net electricity generation.

3.4 Fuel and O&M cost of SMART

The fuel and O&M costs of SMART in this study was obtained from the costs of conventional nuclear power listed as input data for the Long-term Electricity Planning of Korea [2]. An exchange rate of 1,000Won/USD was used.

4. Estimation of the Competitive Exporting Price of SMART

The competitive exporting price of SMART in equation (2) is sensitive to the levelized generation cost of CCGT and the discount rate. The higher the levelized generation cost of CCGT, the higher the competitive exporting price of SMART. In the case of the discount rate, the higher it is, the lower the competitive exporting price of SMART. The discount rate can be regarded as an indicator reflecting financing ability of the importers. As a high discount rate can be interpreted as low capacity for financing, the importers are not in a position to pay high price for importing SMART.
A sensitivity analysis was conducted regarding the natural gas price and discount rate.
The natural gas price was selected in the sensitivity analysis because fuel cost is the most dominant part of the total cost of CCGT. Natural gas prices in the sensitivity analysis were in the range of 10% and 20% above and below from the reference value of 10.23 ($/MMBtu). In detail, they are 8.18, 9.21, 10.23, 11.25, and 12.28 ($/MMBtu).
Discount rates in the sensitivity analysis were assumed to be 8%, 10% and 12%. As the economy is advanced, the level of discount rate tends to become low. The discount rate used in developing countries is believed to be around 10% a year.

The estimated competitive exporting prices of SMART are given in Table1.

Table1. Estimated Competitive Exporting Price of SMART

(Unit: M$)

Price of natural gas ($/MMBtu)	Discount Rates		
	8%	10%	12%
8.18	641	560	506
9.21	701	608	546
10.23	760	656	586
11.25	820	704	626
12.28	879	752	666

As the demand for SMART is believed to be mainly from developing countries, the competitive exporting price of SMART in the case of a 10% discount rate is the most probable. The exporting price at 10% discount rate is estimated to range from 560 to 752 (M$) depending on the natural gas prices. At the reference price of natural gas, that is, 10.23 $/MMBtu, the competitive exporting price of SMART is estimated to be 656 M$. For the reader's information, Korea imports natural gas at a price of 11.7 $/MMBtu, and the KDI study on SMART conducted in 2008 applied a value as low as 7.23 $/MMBtu.

5. Conclusions

This study provides the methodology and results on the competitive export price of SMART. The message from this study is that the competitive export price of SMART is in the range of 560-752(M$) depending on the price of natural gas. The estimated competitive export price of SMART can be regarded as target value for the construction cost in the development of SMART.

REFERENCES

[1] Projected Costs of Generating Electricity, IEA/NEA(2010)
[2] Long-term Electricity Planning in Korea, Ministry of Knowledge Economy.