Why is sometimes LCOE unrealistic in global NPP business?

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1. Introduction

Levelized Cost of Electricity(LCOE) is one of the most important indicators which represent the economic competitiveness of electricity generation.[1] Recently, many policy decision-makers are using the LCOE to economically compare renewable generation with currently operated generation. LCOE is easy to compare because the input variables are not many and the equation is simple. Despite these advantages, LCOE method has method has some limitations to apply in real energy business because of follows.

First, the loan period is different from the operation period in reality. In most NPP projects, the loan period is shorter than the operation period. If the loan period is shortened, the total interest can be decreased.. Consequently, the average LCOE over the lifecycle can be reduced. However, LCOE conventionally assumes that the loan period in NPP project is same with the operation period.

Second, the discount rate is usually proportional to the interest rate and inflation rate. So, if a country's discount rate is high, this means that the interest rate and inflation rate are also high, which usually can lead to a high tariff growth rate. In real business, if the tariff growth rate is high, energy yield can be increased by the year. Finally, the required LCOE for business feasibility can be varied.

Generally, the operation period and discount rate in the NPP project are longer and higher than the renewable energy project. So, if the loan period and tariff growth rate are not considered in LCOE, the economic value of the NPP project would be would be decreased more than renewable energy project.

This study aims to provide the fluctuation of LCOE according to loan period and tariff growth rate. These results would be helpful to assess new energy project.

2. LCOE

LCOE is the total cost to produce a unit of electricity. The formula is as follow. [2]

$$\text{LCOE} = \frac{OCC \times CRF + Fixed\ O\&M}{8760 \times CF} + FC \times HR + Variable\ O\&M$$

Like above, the LCOE formula consists of several variables. OCC(Overnight Capital Cost) means the total cost to construct the facility. CRF is the abbreviation of the capacity recovery factor. The function is transforming OCC into annualized payment [2]. FC is fuel cost, and CF is capacity factor that represents an indicator of annual utilization rate.

CRF can be calculated "{i(1+i)^n}/{(1+i)^n-1}". Hereby, i is discount rate and n is operation period. This equation assumes that the loan period is equal to operation period. However, this is unrealistic in many power generation energy projects.

In addition, this equation represents the time value for the only cost regardless of tariff growth. From the perspective of the cash flow, this assumption is less-rational in real business and finance. The higher discount rate is, the higher interest and tariff growth rate are. Therefore both cost and income should be considered in reality.

3. Loan period VS Operation period

Operation period is the life-time of power plant to make a profit from generation. Generation type and technology level determine the operation period. However, the loan period is mainly determined by cash flow. If the project can yield stable revenue and enough profit, loan period can be reduced. Also, if the loan period can be shortened, the total amount of interest can be reduced, which lead to being more profitable. So, the actual loan period differs according to the NPP project's financial conditions because each project has different cost, revenue, and financial structure. NEA provided average loan and operation period for each generation type for each generation type as shown in Table 1 [3].

	Nuclear	Coal	Solar
Operation(yr)	60	40	25
Loan(yr)	40	20	15

Table 1. NEA released operation and loan period

4. Discount rate VS Tariff growth rate

The discount rate can transform the future value into the present value. This can be calculated from the weighted average cost of capital (WACC). WACC consists of interest rate and industrial market profit. So, if the discount rate is high, the tariff growth rate is also usually high. Table 2 shows the average national discount rate and tariff growth rate in an advanced and developing country. These rates are calculated from the United States, South Korea, Poland, and Kenya.

	Advanced	Developing
Discount Rate (%)	3	7
Tariff Growth Rate (%)	2.24	5.82

Table 2. The comparison of discount rate and tariff growth rate

Discount rate used to change according to energy source generally. So discount rate used to change according to energy source generally. So many energy economists compare the competitiveness of energy source according to the discount rate. The discount rate of NPP project is usually higher than renewable energy project because of the longer loan period and higher capital expenditure. In particular, this tendency is much severe in developing country. So, the high discount rate can cause escalation of LCOE for the NPP project. In addition, can cause escalation of LCOE if the tariff growth rate is not considered, it can also lead to increase in LCOE.it can also lead to increase in LCOE.

5. Method

This study analyzes how much the LCOE changes according to tariff growth rates and loan period. This study assumes input variables like 5.1 and 5.2section.

5.1 Input Data for LCOE

It is necessary to set input data to calculate LCOE. This study uses the data of the APR1400 nuclear project provided by Korea Power Exchange. [4]

	Unit	APR 1400
Operation Period	yr	60
Capacity	MW	1,400
Capacity Factor	%	85
Construction Cost	Won/kW	2,623,970
O&M Cost	Won/kWmonth	66,305
Discount Rate	%	7

Table 3. Reference input data of APR 1400

5.2 Input Data for Loan period and Tariff growth rate

This study assumed loan period and tariff growth rate as shown in Table 4.

	Unit	Range
Loan Period	yr	18 ~ 60
Tariff growth Rate	%	2.1 ~ 7%

Table 4. The range of input variables

6. Results and Discussions

This section shows the LCOE simulation's results according to the loan period and tariff growth rate.

6.1 The impact of loan period

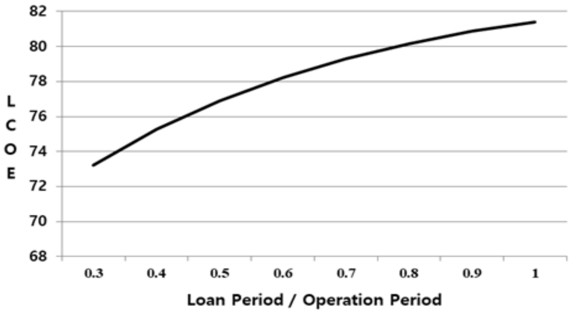

Fig 1. The LCOE value according to loan period's variation

Fig. 1 shows that as the loan period decreases, LCOE also decreases. In this case, if the loan period decreases from 60yr to 30yr, LCOE decreases from 81.4 to 76.9. This is a 5.5% reduction of LCOE, which is considerable value in energy economics.

6.2 The impact of tariff growth rate

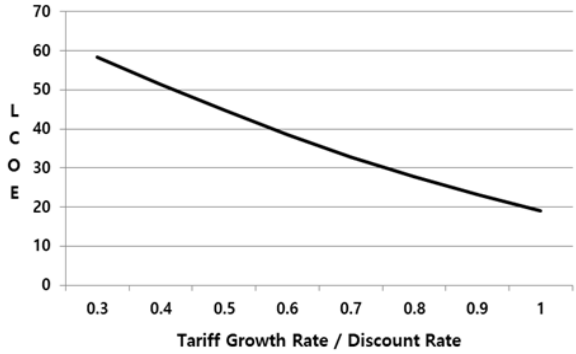

Fig 2. The LCOE value according to tariff growth rate's variation

Fig 2 shows that as the tariff growth rate is higher, LCOE is lower. In this case, if the tariff growth rate increases from 2.1% to 2.8%, LCOE decrease from 58.4 to 51.4. LCOE assumed that tariff is stable. And it doesn't consider tariff growth rate. However, tariff growth rate has a impact on the project's cash flow. And it can drop LCOE value by the year continually.

7. Conclusions

This study simulated the variation of LCOE according to tariff growth rate and loan period. The results show that the consideration of loan period and tariff growth rate has a considerable impact on the LCOE. Of course, these results can be varied depending on the basic input of 5.1section. In the future, authors will assume more various scenarios such as different energy sources and different country using more objective data. This study will support the NPP project to be more competitive compared to the current LCOE evaluation practice.

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