Which one is better to the Economic Welfare: Life Extension or Decommissioning

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1. INTRODUCTION

The purposes of this case study are, firstly, to verify the PLEXFIN[1] in terms of reasonability and consistency regarding simulation results using general parameters so that the people in the nuclear power industry are able to agree with and adjust internally according to their unique technical and financial situation, secondly to demonstrate whether an extension project on hand is economically viable by providing financial performance indicators such as Return on Equity(ROE), Return on Investment(ROI), thirdly, to provide more accessibility and user-friendliness of PLEXFIN to owners of nuclear power plants and users of the program by guiding the locations of essential values to simulate with and then test many different cases.

2. ASSUMPTIONS AND PREDEFINED DATA

2.1 Assumption

In order to calculate the financial performance indicators for the case of a nuclear power plant life extension, it is necessary to set pre-requisite assumptions such as a reactor technology, discount rates and data to estimate cash flows for upcoming years.

■ Reactor Technology

There are two units of PWR which started their commercial operation in 1994 and 1996 respectively. The design life is 30 years and the net design electric rating is 1,000MWe for both units.

Number of units		2 Units
Type		PWR
Design Electric Rating(MWe)	Gross	1,050
	Net	1,000
Operating Capacity Factor (%)		85(Before extension)
		90(After extension)
Year of First Commercial Operation		1994/1996
Design Life (years)		30

■ Discount Rate

We need three kinds of discount rates to properly calculate the financial performance indicators; the expected return on Debt (Kd), the expected return on Equity (Ke) and Weighted Average Cost of Capital (WACC, Ko). Indicators related to Operating profit are calculated by the WACC and those related to Equity and debt (liabilities) are estimated by discounting with Ke and Kd respectively. We assume that Kd is the average rate of return on a company's bonds issued and then Ke is calculated by the formula of the Capital Asset Pricing Model below.

$$K_e = R_f + \beta_L[E(R_m) - R_f].$$

where, R_f is a risk free rate, β_L is the sensitivity of the expected asset returns to the expected market return, $E(R_m)$ is an expected return of market, and β_L is known as the market premium.

The formula of Weighted Average Cost of Capital (K_o) shall be applied to estimate the indicators related to the Earnings Before Interest and Tax (EBIT) which is the blend of equity and liabilities together.

2.2 Predefined data

To test cases, we need to have predefined data; Scenario options, Plant Life Extension (PLEX) assumptions, Business Financial Assumptions, Cost, and Decommissioning related data. Data of Unit 1 and Unit 2 shall mostly be inserted in a separate area respectively.

■ Scenario Options

The common data we assume for the Scenario options sheets are Analysis Start (2014) and End (2050) Years for two units, and then, the other necessary data for each unit shall be inserted as shown in Figure 1. Note that the capacity factor during PLEX outage period should be adjusted reflecting relevant assumptions. In this case study, the capacity factor for PLEX outage period is 0% since it is assumed that PLEX outage will be continued for two full years.

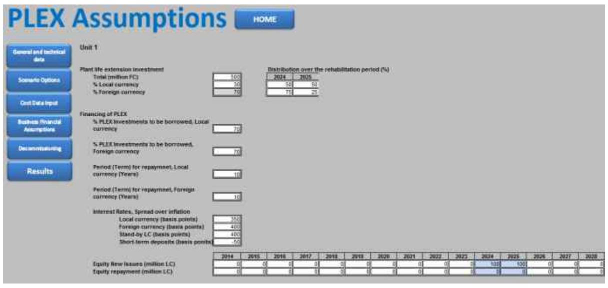
Description		Unit 1	Unit 2
Operating Capacity Factor (%)		85	85
Refuel/Maintenance Outage Duration(Days)		25	25
Planned Operating Cycle Length(Days)		300	300
Remaining Life As of 2014-01-01		10	10
Plant Life Extension (PLEX)	PLEX Outage	Unit 1	Unit 2
	Start date	01-01-2024	01-01-2026
	End date	31-12-2025	31-12-2027
	Duration(days)	730	729
New Operating Capacity Factor (%)		90	90

■ PLEX Assumptions

The data for the PLEX Assumptions sheets consist of Plant life extension investment, Financing of PLEX with % PLEX investment to be borrowed in local and foreign currency, Period for repayment, Interest Rates and Spread over inflation, etc. as shown in Figure 2.

[1] PLEXFIN model has been developed by IAEA(2007) to carry out a financial planning analysis of a power expansion programme and to determine whether such a programme is viable one for the utility and the country involved

Required assumptions shall be filled according to the financing strategy for the Plant life extension investment. Regarding the borrowing % of PLEX investment and the amount of new equity issued, adjustments to initial assumptions may be required in case the level of cash and deposits on the balance sheet is excessively high. Adjustments can be reiterative in order to choose the optimal financing strategy.



■ Business Financial Assumptions

The data for the Business Financial Assumptions sheet consist of Inflation, Exchange Rate, Price of Power Sold, Escalation Rates, Taxation, Depreciation parameters and Initial Balance Sheet. This sheet also includes the assumption of the initial Balance Sheet.

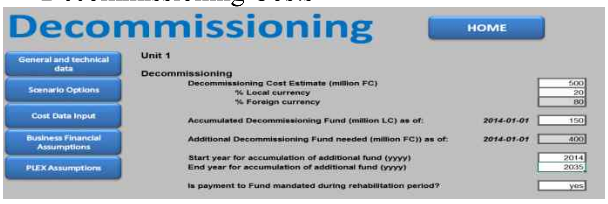
Description			Value
Infla-tion (%)	Base year	Local currency	2
		Foreign currency	2
	Future year	Local currency	3
		Foreign currency	2
Exchange Rates (%)		Base year	1.5
		Future year	1.5
Price of Power Sold		Base year price (LC/KWh)	0.057
		Difference between growth rate and inflation (%)	-1
Escalation rates (%)		Fuel costs (LC)	0.5
		Fuel costs (FC)	0.5
		O&M costs	0.5
Taxation (2013) (%)		Income tax	20
		Royalties/Local tax	4
		VAT rate	10
		% investment with late VAT recovery	100
Depreciation parameters (2013) (%)		Calculation method	Linear
		Parameter 1 (years)	10
		Depreciation for existing assets	10
Exiting Long Term Loans		LC outstanding (million LC)	100
		FC outstanding (million FC)	120
		Interest rate (LC) (%)	3.5
		Interest rate (FC) (%)	4.0
	Repayment	million LC (2014 to 2019)	20
		million FC (2014 to 2016)	40
		Planned Dividend Rate (%)	50

Initial Balance Sheet	2013
Assets	
Gross Assets (million LC)	5000
Accumulated Depreciation (million LC)	3000
Net Assets (million LC)	2000
Work in Progress (million LC)	0
Short Term Deposits (million LC)	0
Total (million LC)	2000
Equity and Liabilities	
Existing equity (million LC)	1500
Retained Earnings (million LC)	220
Existing local loans (million LC)	80
Existing Foreign Loans (million LC)	120
Bonds outstanding (million LC)	0
Current maturity (million LC)	80
Total (million LC)	2000

■ Cost Input data

Description		Each Unit
Reference Annual Nuclear Fuel Expenses	Total (million FC)	20
	% Local currency	5
	% Foreign currency	95
Nuclear O&M Costs	Total (million FC)	80
A&G Costs (million FC)	Pure A&G	20
	Waste Treatment Costs	10
	Social Costs	5

■ Decommissioning Costs

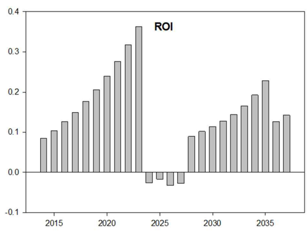


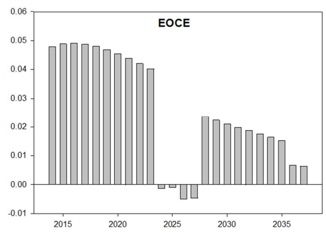
3. EMPIRICAL RESULTS

3.1 ROI/ROE

$$ROI = \frac{Earnings\ Before\ Interest\ and\ Taxes\ X\ (1 - Tax\ Rate)}{(Beginning\ and\ Ending\ Net\ Fixed\ Asset + Beginning\ and\ Ending\ Work\ in\ process + Beginning\ and\ Ending\ Accounts\ Receivable)/2}$$

$$EOCE = \frac{\sum_{i=1}^{n} EBIT_i/(1 + WACC)^i}{(\sum_{i=1}^{n} (Ending\ Gross\ Fixed\ Asset_i - Beginning\ Gross\ Fixed\ Asset_i))/(1 + Inflation\ rate)^i}$$





4. CONCLUSION

We reached the conclusion that the life extension is far economic than going into the decommissioning as soon as a NPP is on its design life. However, various geographical, economic environment and political issues including public acceptance that a country is involved should be crucial parameters for an owners of power plant to consider.

REFERENCES

[1] IAEA(2007), PLEXFIN, A computer model for the economic Assessment of NPP life extension.
[2] I.M Pandey (2015), Financial Management.