Financial Risk Assessment of Transmission Line Projects in Nepal: A Case study of Chilime-Trishuli Transmission Line Project

Dristi Pandey[1], Amrit Man Nakarmi[2]

[1,2] *Department of Mechanical Engineering, Institute of Engineering, Central Campus, Pulchowk*

Corresponding Email: dristipandey@nea.org.np

Abstract: This paper is an attempt to do risk assessment of transmission line projects in Nepal considering all the financial aspects so that the problem that persists in the construction of transmission line project due to various uncertainty situations could be minimized. Various risk involved during the construction of the transmission line and their effect on the net present worth of the project has been analyzed using the Monte-Carlo simulation for the establishment of profitable independent transmission line project. The power transferred from the project has been compared with the electricity demand and the load shedding projected for entire life span of the project for the Kathmandu Valley.

Keywords: financial risk assessment; transmission line; Chilime; Trishuli; wheeling charge, demand forecast; simulation

1. Introduction

The consumption of electricity is one of the most important basic necessities and it indicates the country's development and the people standard of living. Electricity demand in Nepal is growing at an average annual rate of 9% during last decade. Nepal Electricity Authority (NEA), the only public utility in Nepal responsible for generation, transmission and distribution of electricity is finding difficulty to cope with the increasing demand due to poor investment in generation and transmission in the past. The potential Hydroelectric Projects (HEPs) are located in the remote areas of mid hills in Nepal, whereas the electricity demand is high in the industrial areas located at Terai region. As a result development of HEPs depends upon the capacity of the transmission grid to evacuate electricity from the HEPs to the load centers. The major energy crisis has been attributed to the transportation of electricity that is poor due to lack of infrastructure and weakness of existing transmission infrastructures driving lack of investment in generation.

Government of Nepal (GoN), through its Policy and program is encouraging Independent Power Producers (IPP) to develop Hydroelectricity in Nepal which has led to increased participation of private parties on production of electricity. To evacuate the power generated from the upcoming hydro power plants, development of associated transmission line and substations has become of utmost important.(Nepal Electricity Authority, 2012/2013). NEA has a plan to install the new transmission line to respond the increasing demand of both business and household. GoN has the project investment in the new electricity transmission line. However, GoN lacks proper project planning in the construction of the project and various risk involved in the project are not calculated. There are many uncertainty factors in the project evaluation. This has been one of the major reasons for the government and NEA unable to complete the transmission line project within the allocated time frame.

1.1 Chilime–Trishuli Transmission line project

It is 220kV transmission line, 40 km in lenghth, DC, from Chilime to Trishuli 3B substation hub. It consists of 220/132kV, 2X100MVA Substation HUB at Chilime and 220kV Line Bays Extension at Trishuli3B Hub switching substation. The objective of this project is to increase power evacuation capacity of the IPP's upcoming in the Chilime-Trishuli Corridor. The total cost of this project is estimated to US$ 35.0 Million and it is funded by GoN. Project started at FY 067/68 and was earlier expected to be completed by FY 2072/073 (2015/016). Chilime-Trishuli transmission line is intended for evacuation of power generated by independent power producers (IPPs) to national grid and system reinforcement (Nepal Electricity Authority, 2014).

2. Need of Risk Assessment

To meet the growing electricity demand Government of Nepal (GoN) has focused on promoting private power through changes in prevalent rules and regulation. Current existing of inadequate power supply can be tackled by generation upgrade and/or expansion. This means that more generating units must be added to existing power plants or new power plants should be built at new locations in a nation's power grid.

The completion of Chilime - Trishuli projects is very essential to solve the current energy crisis of Nepal. There are many IPPs that have acquired survey licenses for developing hydropower plants in the Trishuli river basins. Different IPPs are developing in Chilime - Trishuli basin which includes Upper Trishuli 3A hydroelectric power (HEP) project (60 MW), Upper Trishuli 3B HEP (36 MW), Upper Sanjen (14.6 MW), Sanjen (42.5 MW), Rasuwagadhi (111 MW), Upper Mailung (14.3 MW), Upper Mailung A (5 MW), Aankhu Khola (42.9 MW) which are planned to be commissioned till 2016/17(Nepal Electricity authority). The existing capacity is not adequate for the demand in the future. Hence, the construction this transmission line is important for the nation. NEA has a plan to install the new transmission line to respond the increasing demand of both business and household. GoN has the project investment in the new electricity transmission line. However, GoN lacks proper project planning in the construction of the project and various risk involved in the project are not calculated. The energy generated by the 12 hydropower projects connected to the Project will be transmitted through this line (Nepal Electricity Authority).

3. Literature Review

3.1 Electricity demand Projection

3.1.1 Forecasting

It is the use of historic data to determine the direction of future trends. There are different methods for analyzing time series data. There are several techniques appropriate for stationary when there is no significant upward or downward trend in the data over time and non-stationary time series where there is some upward or downward trend in the data over time. Forecasting or Time series forecasting is the use of a model to forecast future events based on known past events to predict data points before they are measured (Yale university).

The appropriate forecasting techniques for stationary data series are:

1) Moving Average

2) Single Exponential Smoothing

The appropriate forecasting techniques for non-stationary data series are:

1) Double Exponential Method (Holt's Method)

2) Holt's Winter Method

3) Linear and Quadratic Trend Model

4) Quadratic Trend Model with seasonality indices

3.1.2 Linear Regression

Regression analysis is a modeling technique for analyzing the relationship between a continuous (real valued) dependent variable Y and one or more independent variables X1, X2, … Xk. Linear regression attempts to model the relationship between two variables by fitting a linear equation to observed data. One variable is considered to be an explanatory variable, and the other is considered to be a dependent variable. For example, a modeler might want to relate the weights of individuals to their heights using a linear regression model. The goal in regression analysis is to identify a function that describes closely the relationship between these variables so that we can predict what value the dependent variable will assume given specific values for the independent variables.

3.2 Risk assessment

There are many types of risk assessment techniques which can be used in the project analysis to consider uncertainty factors and prepare for facing it. The current usage of risk analysis include risk premium, risk adjusted discount rate, subjective probability, decision analysis, sensitivity analysis, Monte Carlo simulation. The financial aspect of risk associated with the project was identified to analyse the overall profitability of the existence of a transmission line project.

3.2.1 Monte-Carlo Simulation

Monte Carlo sampling randomly selects sets of values from the input probability distributions to calculate separate discrete results. The results are arrayed in the form of a distribution in order to cover all the possible outcomes. Monte Carlo simulation is a computerized mathematical technique that allows people to account for risk in quantitative analysis and decision making. The technique is used by professionals of wide range of fields of finance, project management, energy, manufacturing, engineering, research and development, insurance, oil & gas, transportation and the environment.

3.2.2 Probability Distribution Function

A discrete probability distribution function associates a list of probabilities with each possible value of a discrete random variable. The probability distribution function is used to model the probabilities of a discrete random variable is also known as a probability mass function. The probabilities of a continuous random variable are modeled using continuous distribution functions, also known as probability density functions (PDF).Triangle distribution are investigated the validity assumption which is commonly adopted in Monte Carlo simulation of construction costs. Triangular distribution is often used in the simulation because of its simplicity and ease in dealing with subjective data(Solver).

PDF triangular distribution =

2(x-a) / [(b-a) (c-a)], if $a \le x \le c$ …….(1)

2(b-x) / [(b-a) (b-c)], if $c \le x \le b$

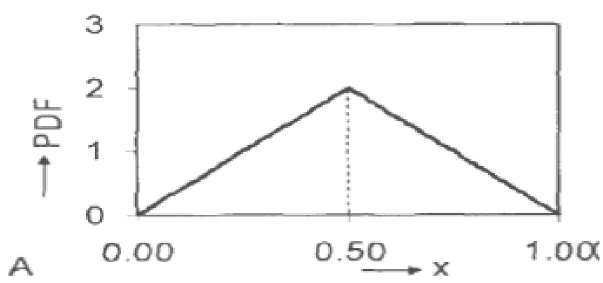

Figure 1: Triangular distribution

4. Methodology

The risk assessment of transmission network is done separately considering for both for those planned projects and upcoming future hydropower project using various cases. The project will take wheeling charge at fixed rate of electricity transmission as revenue from the generating company.The risk factors identified in the project evaluation has direct effect on the net present worth of the project.

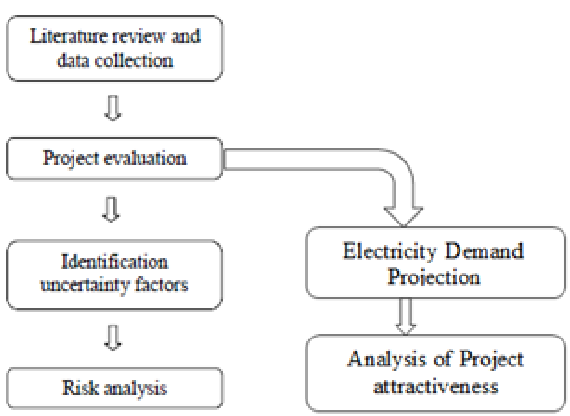

Figure 2: Flowchart of Methodology followed

The electricity demand is projected using simple regression using the GDP and population. The demand of the kathmandu valley is forecasted to know the how current load sheeding problem will be solved after completion of the line. The process of the study followed is illustrated in the flowchart given in Figure 2.

Monte Carlo Simulation was used to evaluate risk of the project. Various Uncertainty factors are identified as risk such as O&M cost and discount rate, initial project cost. Each factor is analyzed in because they will have the direct effect on the project investment and decision making.

5. Data Analysis and Result

Monte-Carlo simulation was done to analyze various risk cases. The simulation was done with 1000 trials. The level of confidence was 95%. There were total 24 assumptions that follow triangular distribution. The number of forecast was 16.

5.1 Electricity Demand Projection

NEA has estimated that that the demand , peak load (MW) as well as energy consumption (GWh) will roughly triple within 15 years or so from now adding on top demand of approx. 2,400 MW and 12,000 GWh over the entire period. The demand will increase almost 800 MW and 4,000 GWh every five years roughly.

For the forecasting the historical data of the past ten years is taken. Then projection of demand upto 30 years of Nepal and Kathmandu valley is done by simple regression using the population and the GDP. From the projection and the data of electricity transmitted from the line, it can be estimated that the energy that is currently shedded in Kathmandu valley now and that will be shedded for upcoming 30 years will come to end. The deficit electricity demand of Kathmandu valley will be transmitted through this line. There will no loadshedding for upto 2105 B.S(Statistics, 2011). However the line will unable to meet the demand of Kathmandu valley then after. The formula used for forecasting from regression is as follows:

Energy demand (GWh) = -8541.93+721.28*(GDP in billion US $) + 221.98*(POP in million) …….(2)

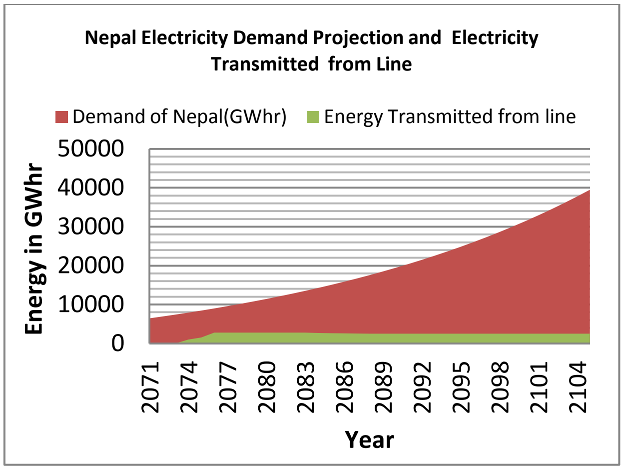

Figure 3: Projection of Nepal Energy demand and Energy transmitted from line

The electricity demand of Nepal is projected. 29.2% of total electricity distributed by the Nepal Electricity Authority is consumed in Kathmandu Valley alone (Adhikari, 2012). It is estimated that 60% from energy transmitted will be distributed to fulfill demand of Kathmandu valley.

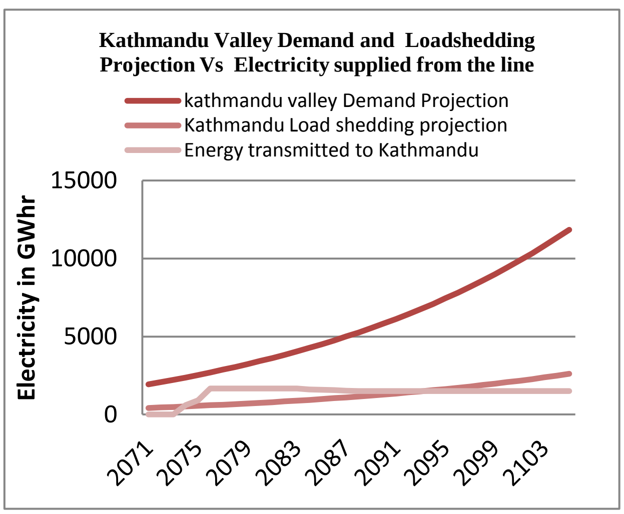

Figure 4: Projection of Kathmandu Energy demand , loadshedding and Energy transmitted from line

The actual estimation of the demand is not possible through projection. The electricity demand during the entire life cycle of the project may vary and is uncertain. This uncertain factor directly affects the net worth of the project.

5.2 *Risk Factor Cases*

For analysis of risk of the project, various risk factors that affect the cost, net present value (NPV), internal rate of return (IRR) and benefit of the project must be considered. The following risk factor cases were considered.

Table 1: Risk factors cases analyzed

	Risk factor Cases	Value
Case 1:	O &M cost	5% annually
Case 2:	Wheeling charge per Kwhr	0.60
	Wheeling charge escalation rate	10%
Case 3:	Interest rate	8%
Case 4:	Land acquiring cost	10%fluctuation
	Contigency	10%
Case 5:	Depreciation rate	5%
	Insurance	0.25%
	Capital expenditure	1,000,000
	Capital expenditure increase rate	5%
Case 6:	Construction delay	Average: 2.15 years
Case 7:	Exchange rate US $ to NPR	98.49
Case 8:	All case 1 to case 7 combined	

5.2.1 *Case 1: Operation and maintenance cost*

Operation and maintenance cost of the project is calculated at 5% annually of the initial project cost which is uncertain. This project introduces 220 kV voltage level which is new for NEA to operate and maintain challenging its operational capacity. There will be many operational losses involved in the project. This study assumes that it can vary from expected value in both positive and negative way and follows triangular distribution. From the simulation of 1000 trials of NPW following result was obtained.
Calculation for NPV:

Table 2: NPV value statistics for case 1 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	360,704,822
Base Case	381,278,249	10%	369,836,282
Mean	381,274,556	20%	373,583,044
Median	381,189,281	30%	376,602,559
Mode	---	40%	379,264,891
Std. Deviation	8,532,824	50%	381,186,155
Variance	72,809,089,789,452	60%	383,300,443
Skewness	0.0043	70%	385,920,765
Kurtosis	2.44	80%	388,797,783
Coeff. of Variation	0.0224	90%	392,976,563
Minimum	360,704,822	100%	401,362,716
Maximum	401,362,716		
Range Width	40,657,894		
Mean Std. Err	269,832		

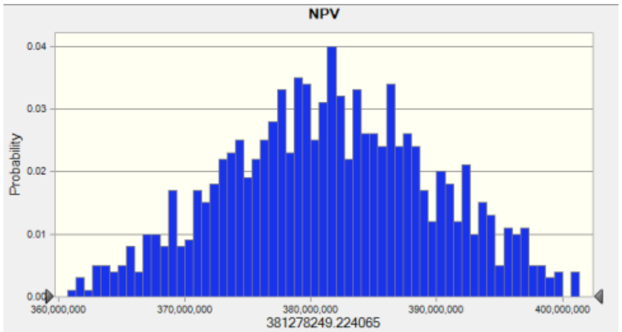

Figure 5: NPV of Case 1 for 1000 trials

The range is from 360,704,822 to 401,362,716. Base case is 381, 278,24. After 1,000 trials, the std. error of the mean is 269,832.

5.2.2 Case 2: Wheeling charge per Kwhr and Wheeling charge escalation rate

This study assumes that the transmission line takes wheeling charge from the generating company at the rate of 60 paisa per kilowatt hour transmission and it is increased at 10% annually (Nepal Electricity Authority, 2014). It can vary from expected value in both positive and negative way and follows triangular distribution.

Calculation for NPV

Table 3: NPV value statistics for case 2 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	46,655,017
Base Case	381,278,249	10%	159,846,226
Mean	443,969,543	20%	217,623,403
Median	379,405,657	30%	264,960,506
Mode	---	40%	321,584,525
Std. Deviation	273,720,382	50%	379,394,557
Variance	74922847256 050000	60%	437,146,171
Skewness	1.10	70%	523,126,958
Kurtosis	3.90	80%	657,915,301
Coeff. of Variation	0.6165	90%	850,137,846
Minimum	46,655,017	100%	1,487,609,700
Maximum	1,487,609,70 0		
Range Width	1,440,954,68 4		
Mean Std. Error	8,655,798		

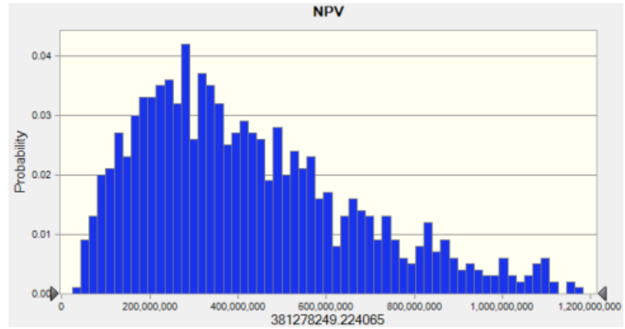

Figure 6: NPV of Case 2 for 1000 trials

The range varies from 46,655,017 to 1,487,609,700. Base case is 381,278,249 .After 1,000 trials; the std. error of the mean is 8,655,798.

5.2.3 Case 3: Variable Interest rate

The interest rate varies fluctuates frequently. This study assumes that the transmission line takes interest from market at 8% and it follows triangular distribution, ranging from 5% to 12%.The following results was obtained from 1000 trials.

Calculation for NPV:

Table 4: NPV value statistics for case 3 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	85,746,332
Base Case	381,278,249	10%	170,903,023
Mean	385,518,367	20%	219,860,430
Median	360,507,684	30%	265,839,974
Mode	---	40%	309,348,349
Std. Deviation	181,697,366	50%	360,120,605
Variance	3301393268 8236900	60%	404,954,611
Skewness	0.7103	70%	453,160,861
Kurtosis	2.95	80%	540,121,679
Coeff. of Variation	0.4713	90%	651,862,331
Minimum	85,746,332	100%	939,232,608
Maximum	939,232,608		
Range Width	853,486,277		
Mean Std. Error	5,745,775		

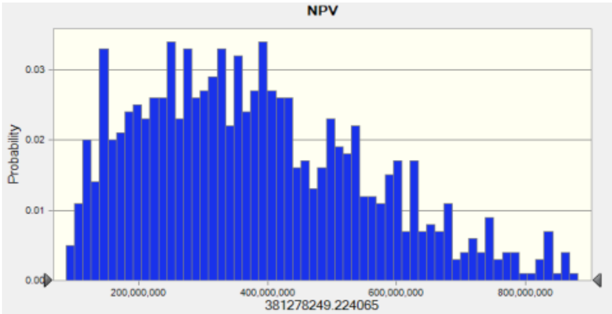

Figure 7: NPV of Case 3 for 1000 trials

The range of NPV varies from 85,746,332 to 939,232,608.Base case is 381,278,249.After 1,000 trials; the std. error of the mean is 5,745,775.

5.2.4 Case 4: Land acquiring and construction cost

The land rate for the area is about 10 million for 1 hectare of land(Nepal Electricity Authority, Monitoring and IT Section, Transmission Directorate) which will be paid to all the acquired land for substation, construction of tower. The land acquiring cost and other project related cost varies from the estimated cost. Similarly there are obstructions created by the locals during construction due to acquisition of their property which delays the construction activity and may cause change in estimated price. This study assumes that the cost can vary from expected value in both positive and negative way and follows triangular distribution. From the simulation of 1000 trials of NPW following result was obtained.

Calculation for NPV

Table 5: NPV value statistics for case 4 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	371,830,510
Base Case	381,278,249	10%	375,703,879
Mean	381,465,327	20%	377,754,167
Median	381,582,430	30%	379,273,603
Mode	---	40%	380,242,786
Standard Deviation	4,164,926	50%	381,578,086
Variance	17,346,607,000,697	60%	382,790,887
Skewness	-0.1233	70%	383,799,045
Kurtosis	2.35	80%	385,323,054
Coeff. of Variation	0.0109	90%	386,816,367
Minimum	371,830,510	100%	390,678,432
Maximum	390,678,432		
Range Width	18,847,921		
Mean Std. Error	131,707		

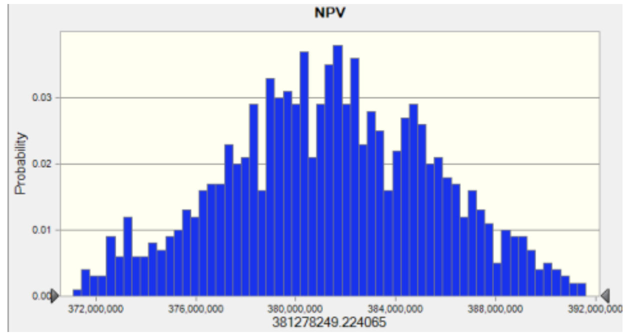

Figure 8: NPV of Case 4 for 1000 trials

The range is from 371,830,510 to 390,678,432.Base case is 381,278,249.After 1,000 trials; the std. error of the mean is 131,707.

5.2.5 Case 5: Project annual operating cost and life span

The project annual operating cost, capital expenditure, insurance and depreciation cost may vary than the actual predicted cost. This affects the NPV of the project. This study assumes that the cost can vary from expected value in both positive and negative way and follows triangular distribution. The result obtained are as follows:

Table 6: NPV value statistics for case 1 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	372,416,570
Base Case	381,278,249	10%	377,769,032
Mean	382,904,083	20%	379,526,282
Median	382,955,323	30%	380,755,206
Mode	---	40%	381,744,694
Std. Deviation	3,924,168	50%	382,950,071
Variance	15,399,097,132,257	60%	384,026,870
Skewness	-0.0423	70%	385,095,016
Kurtosis	2.46	80%	386,481,429
Coeff. of Variation	0.0102	90%	388,072,989
Minimum	372,416,570	100%	392,572,333
Maximum	392,572,333		
Range Width	20,155,763		
Mean Std. Error	124,093		

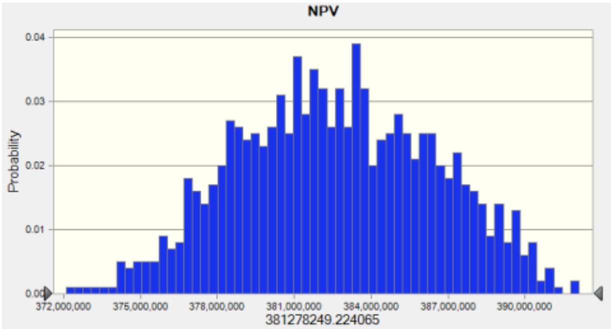

Figure 9: NPV of Case 5 for 1000 trials

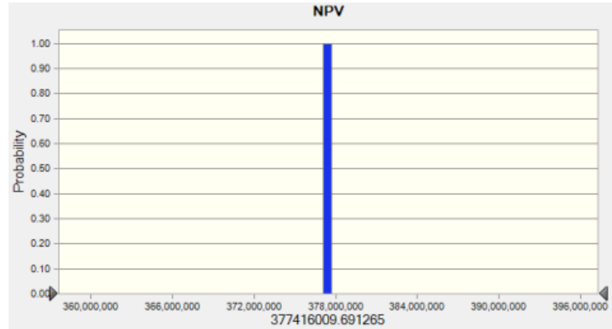

Figure 10: NPV of Case 6 for 1000 trials

The range of NPV is from 372,416,570 to 392,572,333.Base case is 381,278,249.After 1,000 trials; the std. error of the mean is 124,093.

The range of NPV varies from 377,416,010 to 377,416,010.Base case is 377,416,010. After 1,000 trials, the std. error of the mean is 0.

5.2.6 Case 6: Construction delay

Delays in land acquisition, resettlement, funding delays due to obstruction by locals, government procedure and delays due to adverse geology, etc. will affect the overall net present worth of the Project. This also creates problem in loan repayment. Most of the transmission line projects in Nepal are delayed due to various factors which affect the overall cost of the project. From the past record from Nepal Electricity Authority out of total 42 completed and ongoing projects, the total delayed time calculated is 2.15 years. In this case, NPV is calculated for project delay of 2 years.

Calculation for NPV

Table 7: NPV value statistics for case 5 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	377,416,010
Base Case	377,416,010	10%	377,416,010
Mean	377,416,010	20%	377,416,010
Median	377,416,010	30%	377,416,010
Mode	377,416,010	40%	377,416,010
Standard Deviation	0	50%	377,416,010
Variance	0	60%	377,416,010
Skewness	---	70%	377,416,010
Kurtosis	---	80%	377,416,010
Coeff. of Variation	0.00	90%	377,416,010
Minimum	377,416,010	100%	377,416,010
Maximum	377,416,010		
Range Width	0		
Mean Std. Error	0		

5.2.7 Case 7: Exchange rate fluctuation

The project equipment's are purchased using US dollars. Hence the fluctuation in the currency exchange rate, directly affect the project. This study assumes fluctuation in currency exchange rate positively and negatively following triangular distribution. The result obtained is as follows:

Calculation for NPV

Table 8: NPV value statistics for case 7 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	348,084,200
Base Case	381,278,249	10%	361,672,556
Mean	385,599,589	20%	369,379,712
Median	384,400,609	30%	375,683,109
Mode	---	40%	380,229,823
Std. Deviation	17,688,740	50%	384,387,495
Variance	312,891,538,750,910	60%	388,722,422
Skewness	0.1943	70%	395,352,605
Kurtosis	2.42	80%	401,507,552
Coeff. of Variation	0.0459	90%	409,663,953
Minimum	348,084,200	100%	431,457,773
Maximum	431,457,773		
Range Width	83,373,574		
Mean Std. Error	559,367		

The entire range of NPV varies from 348,084,200 to 431,457,773. Base case is 381,278,249. After 1,000 trials, the std. error of the mean is 559,367.

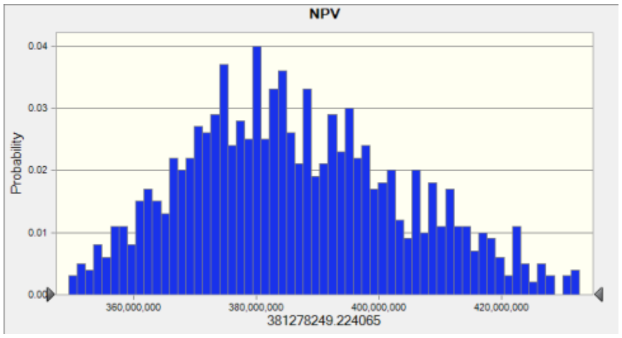

Figure 11: NPV of Case 6 for 1000 trials

5.2.8 Case 8: All case 1 to case 7 combined

All the cases studied have been combined for this case. All the factors that may affect the NPV and the IRR have been calculated in this case following triangular distribution.

Calculation for IRR

Table 9: IRR value statistics for case 1 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	8%
Base Case	14%	10%	11%
Mean	14%	20%	12%
Median	14%	30%	13%
Mode	---	40%	14%
Standard Deviation	2%	50%	14%
Variance	0%	60%	15%
Skewness	0.00082400 9463357701	70%	16%
Kurtosis	2.67	80%	16%
Coeff. of Variation	0.1619	90%	18%
Minimum	8%	100%	21%
Maximum	21%		
Range Width	14%		
Mean Std. Err	0%		

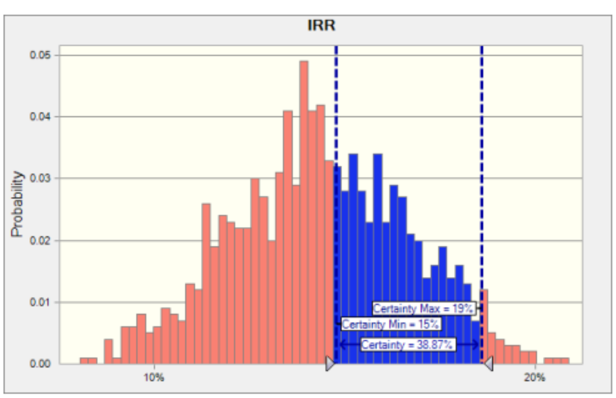

Figure 12: IRR of Case 8 for 1000 trials

The entire range of IRR is from 8% to 21%.Certainty level is 38.9%.Certainty range is from 15% to 19%. Base case is 14%. After 1,000 trials, the std. error of the mean is 0%.

Calculation for NPV

Table 10: NPV value statistics for case 8 of 1,000 random numbers

Statistics	Forecast values	Percentiles	Forecast values
Trials	1,000	0%	163,119,455
Base Case	572,877,141	10%	290,999,817
Mean	627,509,476	20%	356,881,612
Median	543,302,283	30%	417,689,343
Mode	---	40%	471,414,804
Standard Deviation	352,921,566	50%	543,289,300
Variance	12455363195 2145000	60%	613,477,032
Skewness	1.88	70%	707,336,551
Kurtosis	8.35	80%	829,556,044
Coeff. of Variation	0.5624	90%	1,075,982,160
Minimum	163,119,455	100%	3,006,663,394
Maximum	3,006,663,394		
Range Width	2,843,543,940		
Mean Std. Error	11,160,360		

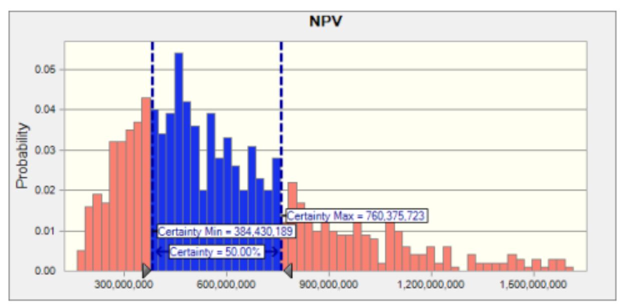

Figure 13: NPV of Case 8 for 1000 trials

NPV entire range is from 163,119,455 to 3,006,663,394. Certainty level is 50.0%.Certainty range is from 384,430,189 to 760,375,723 . Base case is 572,877,141. After 1,000 trials, the std. error of the mean is 11,160,360.

Sensitivity chart of all cases

From the study, it can be seen that the most sensitive is change in wheeling charge, interest rate and the exchange rate fluctuation which is summarized in the table given below. The most sensitive result are highlighted in table below and shown in figure 14 and 15.

Table 11: Comparison of MCS result of NPW

	Minimum	Maximum	Mean	Standard deviation
Base case			381,278,249	
Case 1	360,704,822	401,362,716	381,274,556	8,532,824
Case 2	**46,655,017**	**1,487,609,700**	443,969,543	**273,720,382**
Case 3	**85,746,332**	939,232,608	385,518,367	181,697,366
Case 4	371,830,510	390,678,432	381,465,327	4,164,926
Case 5	372,416,570	392,572,333	382,904,083	3,924,168
Case 6	377,416,010	377,416,010	0	0
Case 7	348,084,200	431,457,773	385,599,589	17,688,740
Case 8	**163,119,455**	3,006,663,394	627,509,476	**352,921,566**

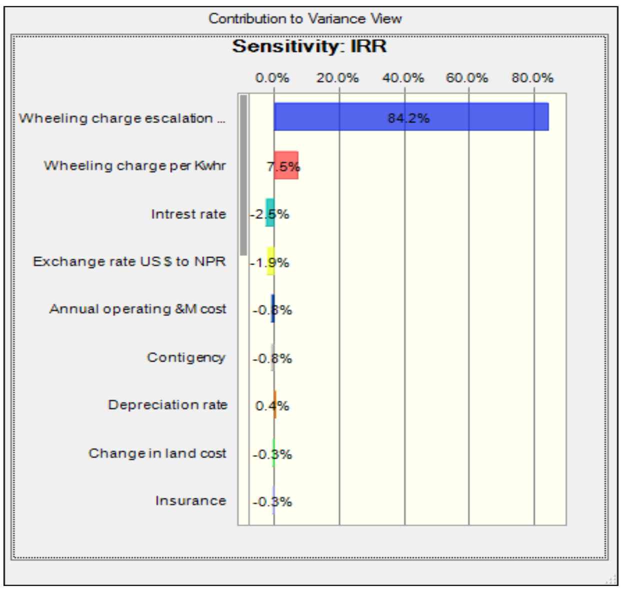

Figure 14: IRR Sensitivity Chart of Case 8

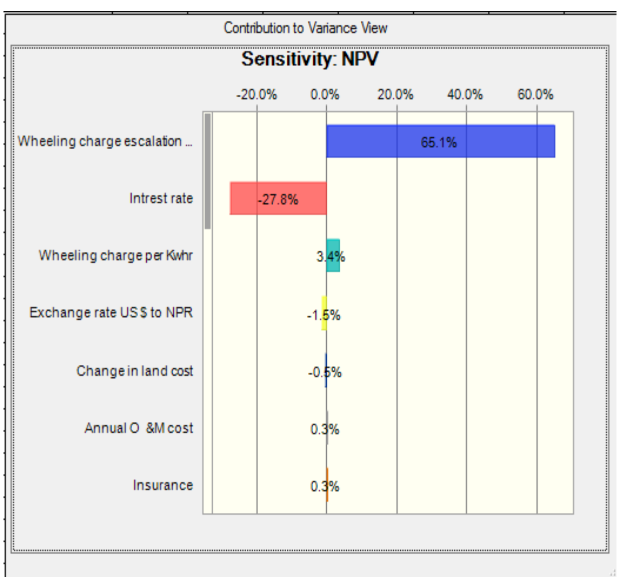

Figure 15: NPV Sensitivity Chart of Case 8

From the study, it can be seen that the most sensitive is change in wheeling charge, interest rate and the exchange rate fluctuation.

6. Conclusion

The risk factors that have been involving several risk factor case has been analysed using Monte Carlo simulation. Combination of various risk factors to analyzed to calculate net present worth and internal rate of return in various risk situation that may exist. Similarly, the calculation of the project attractiveness to the Kathmandu valley also has been done by forecasting the demand using linear regression model. From the analysis it can be concluded that the independent transmission company in context of Nepal is economically feasible.

References

Nepal Electricity Authority. (2012/2013). *A year in Review*. Nepal Electricity Authority.

Abdul Razaque, C. B. (2012). Fostering Project Scheduling and Controlling Risk Management. *International Journal of Business and Social Science Vol. 3 No. 14* .

Adhikari, S. (2012). Electricity Demand Side Management in Residential Sector of Kathmandu Valley.

Amit k Bhandari, A. K. (2014). *Microfinance, Risk-taking Behaviour and Rural Livelihood.*

Arthayookti, N. (1996). *Projects financing for private power producers in Thailand :Risk Analysis of the Rayong Electricity Generating Co., Ltd., AIT Master's research.*

Bhattarai, S. *Analytical hierarchy Process for Rural Micro Project Sustainability monitoring in Nepal.* Kathmandu.

Cyrinus, E. C. (2012). *Long Term Transmission Expansion Planning for Nigerian Deregulated Power System.*

Electricity Demand Side Management in Residential Sector of Kathmandu Valley. (2012). *International Conference on TIM, 2012, Nepal* . Susan Adhikari.

Espen Løken, A. B. (2006). Decision Analysis and Uncertainties in Planning Local Energy Systems. *9th International Conference on Probabilistic Methods Applied to Power Systems.*

Faleye, O. O. (2012). *Moddelling Demang uncertainities in Generation Transmission Expansion Network.* Stockholm.

Fernando Ribeiro, P. F. A Multi-Criteria Decision Analysis Tool to Support Electricity Planning. PERUGIA: 2012.

Gross, B. H. (2009). Risks, revenues and investment in electricity generation:. *Elsevier, Energy Economics 32* .

International, Lahmyer. (2014). *FS 220 kV Trishuli Transmission System Project.*

Investopedia. (n.d.). Retrieved August 20, 2014, from http://www.investopedia.com/terms/f/forecasting.asp

Ma, L. N. (2008). On Transmission Expantion Planning Conidering Security Risk in Competitive Electricity Markets.

Man, H. M. (2004). *Risk analysis for Build-Operate-Transfer (BOT) power project in Vietnam: A case study of "PHU MY 3".*

Marco, M. J. (2013). A Survey on Usage and Diffusion of Project Risk Management Techniques and Software Tools in the Construction Industry . *World Academy of Science, Engineering and Technology Vol:7* .

Maria Daniela CATRINU, D. E. (21-24 May 2007). Multi-criteria Decision Support in Distribution System Asset Management. Vienna.

Naing, T. (2000). *Risk analysis of Hydropower projects in Myanmar : A case study of Paunglaung Hydropower project.*

Nepal Electricity authority. *Trishuli 3A Transmission line Project Design report.* 2011.

Nepal Electricity Authority. (2014). *FS 220 kV Trishuli Transmission System Project.*

Nepal Electricity Authority. *IEE Report - transmission line Upper Trishuli - Matatirtha.*

Nepal Electricity Authority. *Trishuli 3A Transmission line Project Design report.* 2011.

Nepal Electricity Authority, Monitoring and IT Section, Transmission Directorate. (n.d.).

Nepal Oil Corporation. (n.d.). *Nepal Oil Corporation.* Retrieved March 2014, from www.noc.gov.np.

Nepal Rastriya Bank. (2012). *Economic Survey of Fiscal year 2011/12.*

Palisade Corporation. (n.d.). Retrieved August 20, 2014, from http://www.palisade.com/risk/monte_carlo_simulation.asp

Panthi, K. (2004). *Contingency estimation for construction projects through risk analysis : The case of Hydro-Electric power projects in Nepal.* Bangkok.

Raftery. (1994). Risk analysis in project management. *E&FN Spon* , pp. pp 6-23.

Roy Billionton, R. N. *Reliability Evaluation of Engineering Syestem.* Spinger International Edition.

Samuel Bodily, M. D. (n.d.). Risk and reward at the speed of light: a new electricity price model.

Sattawatananon, P. (2011). *Risk Analysis in the Financial Evaluation of Electricity Transmission System Extension Project.*

Solver. (n.d.). Retrieved August 20, 2014, from http://www.solver.com/monte-carlo-simulation-overview#What_is_Monte_Carlo_Simulation

Song, D. (2010). A Risk Management Framework for Electricity Market Planning. *IEEE, volumn 3,* , 341- 345.

Statistics, C. B. (2011). Kathmandu.

Steven. (2003). *Financial Risk Management.*

Tan, T. N. (2013). *Optimal Operations of Cascade Hydropower Plants.*

V M Rao Tummalla, J. R. (1996). Applying a Risk Management to manage cost risk for EHV transmission lines.

Vardanyan, Y. (2012). *On stochastic optimization for short-term hydropower planning.* Stockholm,.

Yale university. (n.d.). Retrieved August 16, 2014, from http://www.stat.yale.edu/Courses/1997-98/101/linreg.htm