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Analysis of Technical and Economics High Voltage Overhead Transmission 150 kV Development in Industrial Area of High Voltage Consumers PT. Lotte Chemical Indonesia

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ABSTRACT

In order to increase revenue, PT PLN (Persero) entered into a power purchase agreement with PT. Lotte Chemical Indonesia Cilegon. investment in the relocation of 150 kV high voltage overhead lines. This research is very important as a small-scale simulation given the large number of electric power transmission projects implemented by PLN. This study analyzes the impact of the relocation of the 150 kV T/L and found that the existing material that was dismantled was either utilized/not reused so that it has the potential to increase/decrease investment for PLN. The research method is in the form of data analysis on the feasibility study of the PLN project. Calculation analysis by calculating the value of existing assets which is then used as a reference in calculating sensitivity analysis which is then determined 3 scenarios using financial indicators IRR, NPV, B/C Ratio and Payback Period (PB). The results of the study show that scenarios 1, 2 and 3 have positive IRR and B/C ratio values and there is a difference of 1 year for the payback period between scenarios 1 and 3 vs scenario 2 and the highest NPV is in scenario 3.

Keywords: *Project Feasibility study, Electric Power Transmission, Sensitivity Analysis*

1. INTRODUCTION

PT. PLN (Persero) West Java Development Main Unit is a PLN unit tasked with carrying out electricity infrastructure development in DKI Jakarta, Banten and parts of West Java. Projects scope are poweIDRlant, transmission and substation construction projects. One of the strategic projects that is PLN's mainstay in order to increase PLN's revenue is the transmission development project in the context of connecting electricity to high voltage consumers (KTT). One of the strategic summits in Banten Province is PT. Lotte Chemical Indonesia, a company engaged in the petrochemical sector which is currently expanding its business after the Covid 19 pandemic. The location of PT. LCI is located in the Merak Industrial Estate. This business expansion will certainly have an impact on electricity consumption in order to meet its business production. In this regard, PT. LCI requires additional electric power from PLN. The additional power is stated in the Power Purchase Agreement between PLN and PT. LCI. For the first phase of 115 MVA in December 2023. Therefore PLN must invest in the construction of electricity installations to fulfill this commitment.

Electricity sales in Banten province are still dominated by industrial customer groups, which are the most strategic source of revenue from PLN's perspective. The need for electricity according to the 2021-2030 RUPTL is projected to increase every year with an average growth of around 3.33% (moderate scenario).

2. BASIC THEORY

Table 1. Demand Projection in Banten Province

No	Year	Economic Growth (%)	Sale (GWh)	Production (GWh)	Peak Load (MW)	Customer
1	2021	4,3	22.943	24.148	3.446	3.649.732
2	2022	4,6	23.721	24.958	3.562	3.823.211
3	2023	4,6	24.526	25.793	3.681	4.003.609
4	2024	4,6	25.363	26.642	3.802	4.191.253
5	2025	4,6	26.256	27.569	3.934	4.386.288
6	2026	4,6	27.201	28.528	4.071	4.588.840
7	2027	4,5	28.085	29.433	4.200	4.798.843
8	2028	4,4	28.976	30.348	4.331	5.016.330
9	2029	4,3	29.882	31.286	4.465	5.241.383
10	2030	4,3	30.888	32.327	4.613	5.478.864
	Growth (%)	4,5	3,33	2,67	2,66	5,10

One of the industrial areas that has strategic value for selling PLN electricity is the Merak industrial area. Within the industrial area there are many large factories with various kinds of production. One of PLN's customers who have strategic value is PT. Lotte Chemical Indonesia, which has been operating around 1990 and has been a PLN customer since that year.

In order to support the business development of PT. Lotte Chemical Indonesia, PLN, in this case as the state company in charge of providing electricity to the public, has an important role in this regard.

In the case of a new investment, PLN needs to develop a program framework contained in the form of a project feasibility study. In the sense that a project feasibility study/study is an assessment that is comprehensive and tries to highlight all aspects of the feasibility of a project or investment. The feasibility parameters of a project are generally seen from 2 aspects, namely technical/operational and financial aspects. From a technical/operational point of view, an electricity project that is deemed feasible must comply with a number of specified principles, such as operational reliability and service quality level. Meanwhile, financially a project is considered feasible if it meets the following criteria:

Table 2. Financial indicators according to the PLN project feasibility study

No.	Financial Indikator	Description
1.	Payback Period (PB)	The sooner the better
2.	Internal Rate Return (IRR)	≥Discount Rate (12 %)
3.	Net Present Value (NPV)	>IDR 0
4.	B/C Ratio	>1

Before determining the feasibility of the project financially, it is first analyzed technically, especially for the distance between towers and the type of conductor to be used. The references used according to PLN standards are as follows:

Table 3. Tower Type for Overhead Line 66 kV & 150 kV

No.	Tower Type	Tower Position	Turning Angle	Insulator Type
1	AA	Suspension	$0^o – 3^o$	Compress
2	BB	Tension	$0^o – 20^o$	Uplift
3	CC	Tension	$20^o – 40^o$	Uplift with outside jumper
4	DD	Tension	$40^o – 60^o$	Uplift with outside jumper
5	EE	Tension	$60^o – 90^o$	Uplift with outside jumper
6	DDR	Tension	Tower terminal $0^o – 60^o$	Uplift with outside jumper

Table 4. Base range, weight range, wind range

No.	Tower	Base Range	Weight Range (m)		Wind Range (m)	
			Normal Condition	Abnormal/ Broken Condition	Normal Condition	Abnormal/ Broken Condition
1	66 kV	300	500	350	450	315
2	150 kV	350	700	400	500	400

3. RESEARCH METHODOLOGY

This research method was carried out using the literature study method through books, journals, research articles, and references both from offline media and from sites available on the internet related to the discussion in this thesis. After the reference data is collected, it is followed by making a research design to answer and analyze the results obtained based on existing literature references with

the formulation of the problem and writing objectives that have been previously set to support the writing of this thesis.

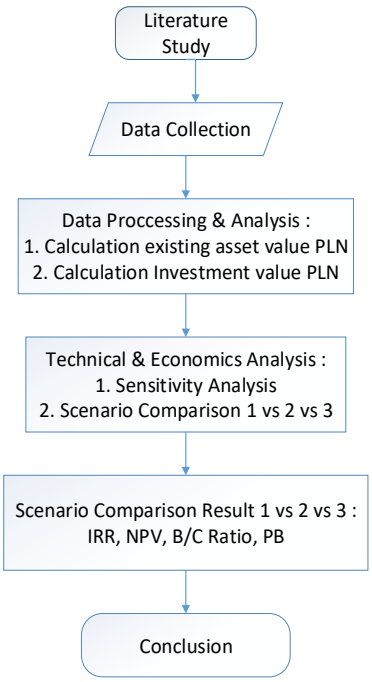

Figure 1. Research Flowchart

The research steps carried out are as follows:

1. Analyze the PLN project feasibility study that has been prepared by PLN regarding the connection of power to high voltage consumers of PT. Lotte Chemical Indonesia
2. Looking for gaps in the PLN Project feasibility study that can be repaired for future improvement
3. Make a new feasibility study design and then compare it with the previous feasibility study including a comparison of the transmission existing utility with the new transmission utility
4. Calculation of a feasible investment to be used as a reference in the preparation of the feasibility study in the future

4. STUDY RESULT

Figure 2. Existing tower to be demolished (dash line)

Figure 3. New line after existing tower relocation (dotted line)

The length of the Existing T/L that crosses the PT. LCI around 900 m requires 3 wickets so that it meets the set criteria (SPLN). Whereas the length of the relocation area is 1500 m so that by design it requires 5 wickets with the calculation of the distance between towers requiring a distance of 300 m according to the SPLN.

It has been known according to field observations that according to specifications the type of conductor for the existing one is ACSR/Drake, so after relocating the tower, at least replace it with the same or better type. According to the PLN contract data for new conductors using the ACCC/Hamburg type. For an explanation according to the table below.

Table 5. ACSR vs ACCC

No.	Conductor Type	Current Rate	Reference
1.	ACSR/Drake	785 A	PLN Feasibility study
2.	ACCC/Hamburg	1858 A	PLN Contract

According to the table above, the loading for the relocated new line is still in a safe condition because the conductor used has a better/greater current rating than the previous one.

The method of dismantling the tower following the transfer to a location to a new tower is a safe system or work because currently the conductor loading according to the PLN feasibility study is only burdened with no more than 50% of the installed conductor capacity. Table explanation of the loading can be seen below.

Table 6. Transmission loading conditions at the LCI Summit location according to the KKP

No.	Conductor Line	Installed Capacity (A)	Type	Peak Load	% In	Peak Load Time
1	Suralaya – Peni	785	1 x Drake	243,7	31,05	19:00
2	Peni – Mitsui	785	1 x Drake	220,2	28,06	19:00
3	Mitsui – Cilegon Lama	785	1 x Drake	758,3	96	10:00
4	Cilegon Lama – MCCI	785	1 x Drake	77	9,81	19:00

In this study, the value of existing assets will be calculated in advance, especially for the T/L transmission line that crosses the project location of PT. Lotte Chemical Indonesia. Primary data obtained from PLN for the existing asset value of the Cilegon Baru – Mitsui – Peni 150 kV overhead transmission is IDR. 82,696,208,710.00. The asset value takes into account the following assets:

1. Tower asset value
2. Conductor's asset value

3. Isolator asset value
4. OPGW/GSW asset value
5. Value of land assets

The new Cilegon – Mitsui – Peni 150 kV T/L line can be seen in the image below.

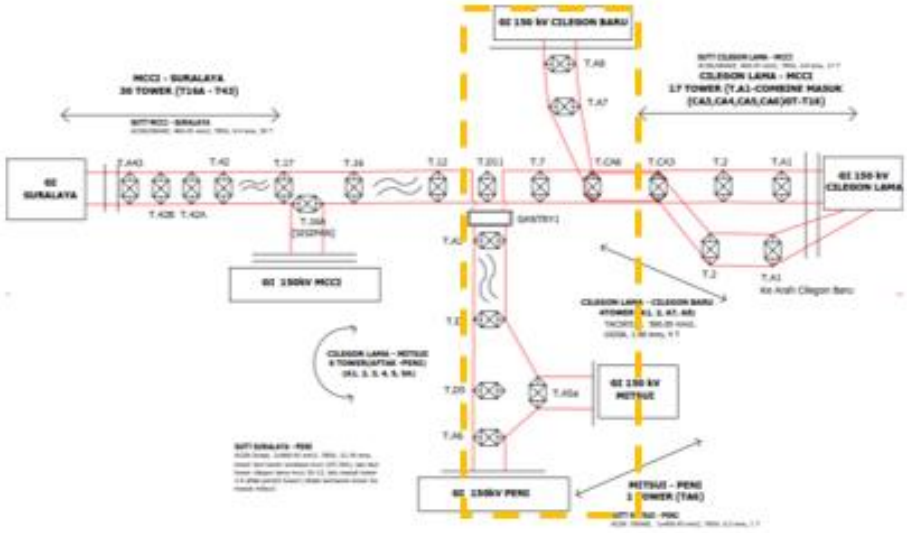

Figure 4. New line after existing tower relocation (dotted line)

In total, from the 150 kV Cilegon Baru - Mitsui - Peni kV overhead transmission line, there are 27 towers along with other materials standing at that location. For the existing route that passes through the construction site for PT. LCI has 7 towers and their accessories. Of the 7 towers and their accessories, there are 4 existing towers that will be dismantled.

Figure 4. The position of the existing assets of the 4 towers along with other main transmission materials that have been dismantled.

The asset value of the 4 towers and their accessories can be calculated using the following calculation:

X = Existing asset value for each tower, conductor, insulator, OPGW/GSW and accessories

Y = Asset value of the 150 kV T/L Cilegon Baru – Mitsui – Peni dismantled
X = Existing line asset value / Number of existing towers
= 82,696,208,710 / 27
= 3,062,822,545
Y = 4 x 3,062,822,545
= 12,251,290,179

Estimated Asset Value of the Existing 150 kV T/L Cilegon Baru – Mitsui – Peni which was dismantled was IDR 12,251,290,179.00.

PLN in this case will invest on requests from PT. LCI, namely the connection of 115 MVA at the end of 2023. The consequences of this as stated in the agreement between PLN and PT. The LCI stated in the PJBTL (Power Purchase Agreement), PLN must dismantle and then relocate the existing tower/tower on the Cilegon Baru – Mitsui - Peni line because at that location an expansion of the petrochemical factory owned by PT. LCI.

Investments that PLN must make to support connection to premium customers include:

1. Land Procurement for the Tower. 14 The following is the cost of consulting services
2. Procurement of Services and Materials for the relocated Tower including the cost of dismantling the existing tower and the 2 Line Bay (LB) GI 150 kV Peni Works

If detailed in a calculation that is in accordance with various existing sources, the investment calculation is obtained as follows:

Table 7. PLN Investment

No	PLN Cost	Nominal	Reference
1	Consultant Appraisal Fee	IDR 8,544,225.00	PLN Contract
2	Land Acquisition Cost T.14	IDR 2,091,707,080.00	Consultant Appraisal
3	Procurement of Services and Materials for the relocated Tower including the cost of dismantling the existing tower and the 2 Line Bay (LB) GI 150 kV Peni Works	IDR 46,324,872,561.00	PLN Contract
	Total Cost	IDR 48,425,123,866.00	

Sensitivity analysis, as explained briefly on the theoretical basis, has the goal of knowing financial indicators in an investment. In this study will be divided into 3 analysis scenarios:

1. Analysis according to FS
2. FS Analysis + Existing asset value
3. FS Analysis – Existing asset values

The scenario above according to FS includes 3 works, namely:

1. T/L Relocation Work and 2 Line Bay GI. Peni (Research Object)
2. IBT Uprating Work at the Old Suralaya GITET and New Suralaya GISTET
3. T/L 150 kV Conductor Replacement Work Suralaya – Mitsubishi – Old Cilegon – Mitsui – Peni – Suralaya

The total investment for the three works according to the FS is IDR 282,018,000,000.00

Scenario 1

This scenario includes a financial analysis according to the project feasibility study. With a total investment value calculation of IDR 282,018,000,000.00, the simulation results obtained are as follows:

Table 8. Financial Indicator Scenario 1

No.	Financial Indicator	Description
1.	Payback Period (PB)	5 year
2.	Internal Rate Return (IRR)	19,92%
3.	Net Present Value (NPV)	IDR 121,274,390,000.00
4.	B/C Ratio	1,05

Scenario 2

This scenario uses FS analysis calculations added to the previously calculated existing asset values. This calculation focuses on assets that are dismantled, all of which are not reused by PLN. The total investment issued according to scenario 2 is as follows:

Scenario 2 value = Value according to scenario 1 +
Existing asset value
= 282,018,000,000.00 +
12,251,290,179.00
= IDR 294,269,290,179.00

Table 9. Indikator Finansial Scenario 2

No.	Financial Indicator	Description
1.	Payback Period (PB)	6 tahun
2.	Internal Rate Return (IRR)	18,87%
3.	Net Present Value (NPV)	IDR 110.299.620.000,00
4.	B/C Ratio	1,04

Scenario 3

This scenario uses feasibility study analysis calculations added to the previously calculated existing asset values. This calculation focuses on dismantled assets that can be reused by PLN either for own use in other locations or sold with the assumption that they are 100% used. The total investment issued according to scenario 2 is as follows:

Scenario 3 value = Value according to scenario 1 –
Existing asset value
= IDR 282,018,000,000.00 - IDR
12,251,290,179.00
= IDR 269,766,709,821.00

Table 10. Financial Indicator Scenario 3

No.	Financial Indicator	Description
1.	Payback Period (PB)	5 year
2.	Internal Rate Return (IRR)	21,08%
3.	Net Present Value (NPV)	IDR 132,249,160,000.00
4.	B/C Ratio	1,05

From the calculation of the 3 scenarios above, it is found that there are differences, especially in terms of payback period (PB):

1. PB Scenario 1 : 5 years
2. PB Scenario 2 : 6 years
3. PB Scenario 3 : 5 years

With positive IRR, NPV, B/C ratio indicators (profit) with NPV and IRR values in scenario 3.

5. CONCLUSION

Based on the discussion and analysis carried out in the previous chapter, the following conclusions can be drawn:

1. Technically, the demolition of the tower following the transfer to a new tower location is systemically safe and does not have the potential to disrupt PLN services to customers.
2. The results of the sensitivity analysis show that:
   a. Existing assets are used as a deduction for investment found IRR values, B/C ratios, NPVs with positive results with a payback period equal to 5 years with the highest NPV and IRR.
   b. Existing assets are used as an investment additive found IRR values, B/C ratios, NPV positive results with a payback period of 6 years.
3. The investment made is still feasible with a positive IRR, B/C ratio, NPV in scenario 3 even though the payback period (PB) is delayed by 1 year.

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