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Repair of Technical Losses in the Distribution Network at Feeder

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ABSTRACT

This research aims to analyze and improve technical losses on feeder 05 at PLN ULP Kruenggeukueh. The research methods used included field surveys, data collection, and simulations using ETAP and MATLAB software. The technical depreciation that occurred was 31.6 kW in the MATLAB simulation and 41.8 kW in the gradual simulation. The shrinkage that occurs in the medium voltage network in the Krueng Geukueh 05 ULP extension is still by SPLN NO.72 of 1987 standards where the technical shrinkage that occurs is still below 10%. Future improvements should be made by increasing the conductor cross-section and increasing the capacity of the distribution transformer according to its power.

1. Introduction

The growth in demand for electrical energy is very large at this time is a sign that the economy of society is getting better, of course, it requires an additional supply of energy from new generators [21,23]. Electrical energy is one of the energies that affect human life [8,21,24].The need for electrical energy always increases from year to year along with the continued growth of electrical energy distribution that runs well with adequate quality of electricity distribution standards [2,4,10,19]. The population growth rate continues to increase directly proportional to the growing need for electrical energy every year, this is what causes problems for the State Electricity Company (PLN) [15,24,26]. The source of electrical energy supplied by PLN is not all that can be received by consumers because some are lost in a state of electrical power loss or losses [22]. Of course, this problem can disrupt the availability of electrical energy for customers [11]. According to Article 28 of Law No. 30 of 2009 on electricity, an Electricity provider that has a business license is obliged to provide electricity that meets the applicable quality and reliability standards and provides the best service to consumers and the community [5]. This encourages electricity providers to improve the quality of their services. The availability of adequate and good quality electricity is important for the community and industry in

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supporting daily activities, as well as maintaining a better economic level [14,24]. Of course, power quality is related to the interaction between electric utilities and customers [4,13].

In the distribution of electrical energy, several obstacles can reduce the electrical power flow, one of which is losses or shrinkage of electrical power [3,17,25]. Losses or shrinkage of electric power is the reduction of electrical energy received by consumers, meaning that there is some electrical energy lost in the 2 distribution processes, in this case, the electrical energy provider (PLN) suffers losses [6,16]. Therefore, controlling the use of electricity is very important which involves planning, inspection, action, and also completion of the installation of electricity users from PLN [12,20].

Research with a linear topic has also been carried out previously by Erhanaeli et al, namely Improvement of the Technical Loss Value of Medium Voltage Network Feeder 5 Matur PT PLN Rayon Koto Tuo using ETAP 12.6 with the results of analysis and calculations obtained power loss before repair of 2.18% and voltage loss of 4. 43%, after updating the conductor there was a decrease in power loss to 1.13% and voltage loss to 2.22%. Based on these results, the technical loss value is reduced by conducting uprating of the conductor [1]. This research aims to analyze how much technical loss has occurred and correct it using MATLAB and ETAP software on the 05 Kreung Geukueh ULP feeder.

The amount of energy loss from PLN is in the form of a global percentage, to be able to reduce the energy loss figure more effectively, namely by separating losses between technical and non-technical. So that the main cause of distribution losses can be identified. Then solutions can be found to reduce the value of these losses [18], so technical efforts are needed to reduce these losses [2,7].

2. Methodology

2.1 Research Stages

The research stages carried out on power losses and energy losses at the Kreung Geukeuh Customer Service Unit (ULP) have been summarized in a flow diagram which can be seen in the image below.

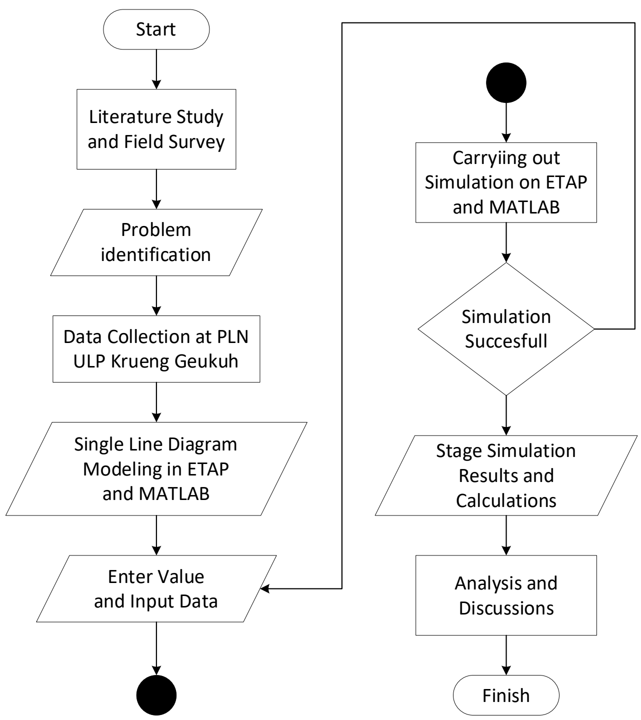

Fig. 1. Research flow chart

2.2 Retrieval of Data on feeder 05 at PLN ULP Krueng Geukueh

Based on the data collection method described above, the data used in this research consists of load data, length data, distribution transformer data, and other data taken from the 05 ULP Krueng Geukueh feeder.

2.2.1 Single line diagram of feeder 05 ULP Kreung Geukuh which consists of two SLDs which can be seen in Figure 2 and Figure 3 below

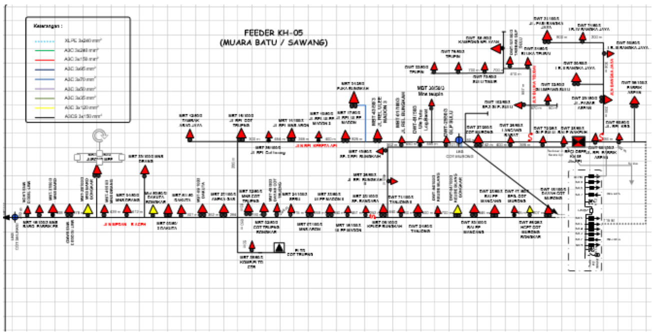

Fig. 2. SLD feeder 05(1) Krueng Geukueh

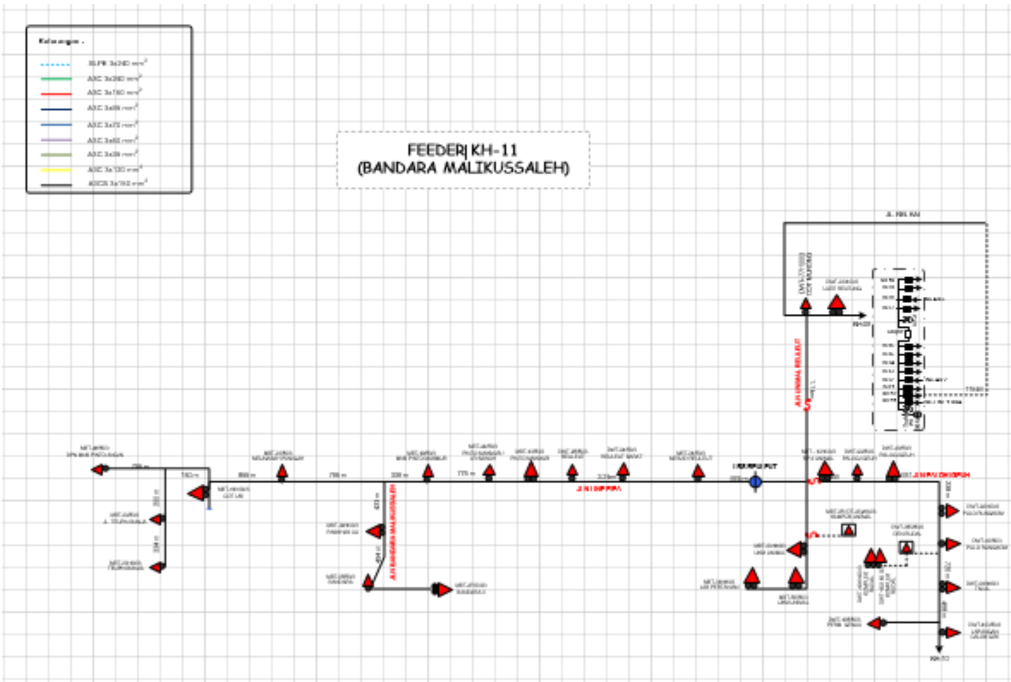

Fig. 3. SLD feeder 05(2) Krueng Geukueh

2.2.2 The distribution channels at feeder 05 ULP Kreung Geukuh consist of SUTM and SKTM. The type of conductor used in this feeder distribution channel is AAACS with a cross-sectional area of the conductor of 150 mm^2. The length of the channel containing the channel from the ULP to the distribution transformer is 29,997 km

2.2.3 Daily load data on feeder 05 ULP Kreung Geukeuh consists of substation code, current, voltage and end voltage with a total of 94 substation codes

2.2.4 Transformer data on feeder 05 consists of phase, transformer power, and number or units used. For more clarity, see Table 1 below

Table 1
Transformer capacity data K.H. 05 ULP Kreung Geukuh

No.	Phasa	Daya Trafo (kVA)	Jumlah (buah)
1		25	2
2		50	56
3	3	100	31
4		160	4
5		630	1
		Jumlah	94

3. Results

3.1 Simulation of Power Losses on ETAP

Feeder 05 ULP Kreung Geukueh is supplied directly from the Kreung Geukueh Main Substation. The number of distribution substations in this extension consists of 94 substations with a capacity of 7,620 kVA. The single-line diagram carried out in the ETAP simulation can be seen in the figure 4 below.

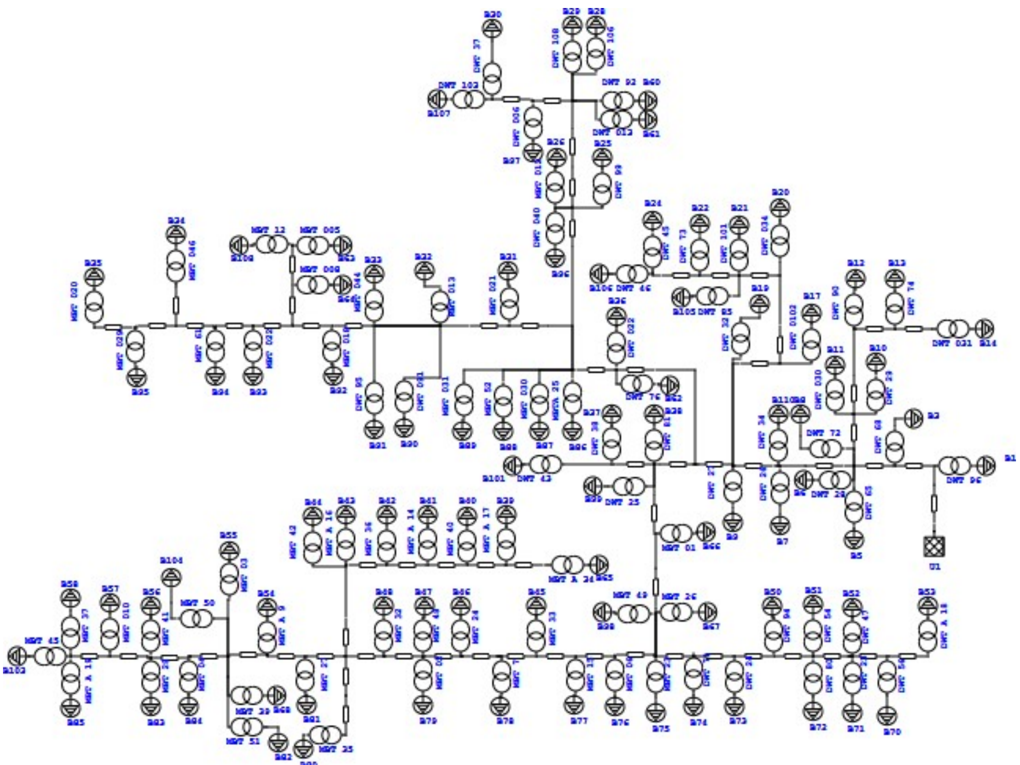

Fig. 4. SLD Feeder 05 ulp Krueng Geukueh on ETAP

3.2 Simulation of Power Loss in MATLAB

The simulation carried out in MATLAB begins with assembling the circuit used. The simulation is done with the Simulink feature in MATLAB and uses a library specifically for power flow as shown in Figure 5 below.

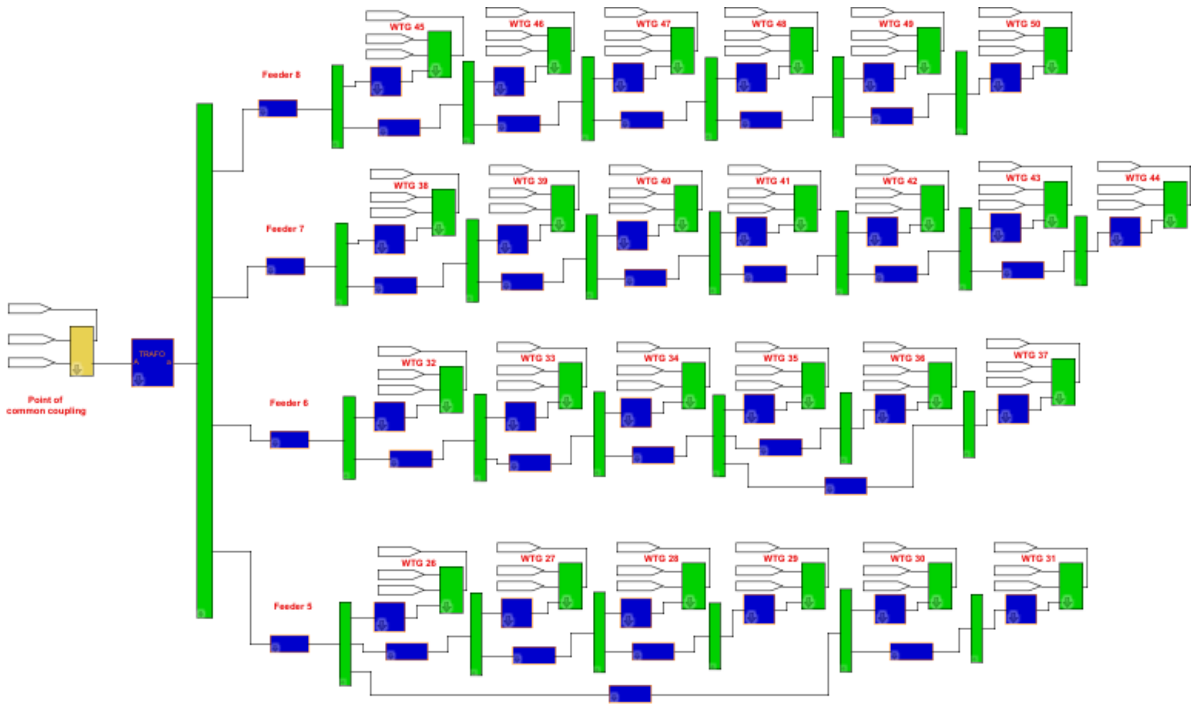

Fig. 5. Power flow simulink circuit in MATLAB

3.3 Comparison of ETAP simulation results with MATLAB

The comparison between ETAP simulation and MATLAB lies in the operation when the simulation will be carried out. The results obtained from both simulations are relatively not far away and the error value is still below 50% as shown in table 2 below. The use of ETAP is more dominant because it is directly in the form of a series of electric power systems, making it easier to analyze data.

Table 2
Comparison of ETAP simulation results with MATLAB

Simulation	Losses	
	kW	kVAR
MATLAB	31,6	24,5
ETAP	41,8	23,5
Difference	10,1926	1,01793

In the table above, the comparative values in both simulations have no significant difference as shown in the figure 6 below. The cause of the difference in values in ETAP and MATLAB simulations is the simulation process carried out in both applications. Then based on the results of simulations conducted in ETAP and MATLAB, the power losses that occur still meet operational standards. This refers to SPLN No. 72 of 1987 where the use of power loss percentage should not be more than 10% of usage.

The resulting power distribution in both simulations has a value of 3.891 MVA. While the power losses generated in both simulations have a value of 31.6kW and 41.8 kW. The minimum power loss value by the standard should not exceed 10% or 330.7 kW. So the percentage of power losses generated from both simulations is only 0.00081152% and 0.10774%.

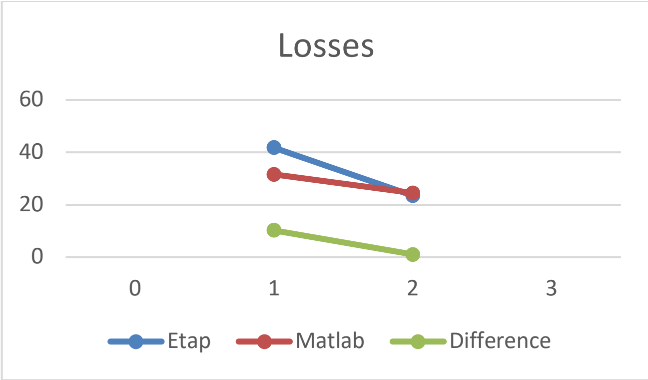

Fig. 6. ETAP comparison curve with MATLAB

3.4 Power Loss Improvement

Repair of power losses contained in feeder 05 ulp Krueng Geukuh is done by enlarging the cross-section of the conductor of the repeater and making improvements to distribution transformers that experience overload which will be explained at the points below.

3.4.1 Enlarge the cross-section

In the ULP Kreung Geukeuh feeder 05 itself there is a cross section that uses a diameter of 95mm. So improvement efforts are made by increasing the cross section to 240mm. The application is carried out on ETAP and MATLAB simulations to reduce the losses experienced. The electric power losses obtained after making improvements to ETAP are 25.8 kW and 22.2 kVAR. While in MATLAB the electric power losses obtained are 29.3 kW and 18.16 kVAR.

The changes that occur after improvement by increasing the cross-section of the conductor are certainly able to reduce the losses that occur. In ETAP alone, the electric power loss is reduced by 5.8kW. While in MATLAB the electric power loss is reduced by 12.5kW.

3.4.1. Increase the capacity of distribution transformers

Feeder 05 ULP Kreung Geukeh still meets SPLN standard No. 72 of 1987. However, when the simulation was carried out in ETAP and MATLAB, some improvements had to be made. Power losses that occur at the 05 ULP Kreung Geukeuh Extension feeder in ETAP and MATLAB are caused by overloads on the distribution transformer. Distribution transformers that experience overload can be seen in the table below.

Table 3
Overloaded distribution transformers

Device ID	Condition	Rating	Operating
DWT 040	Overload	0,050	0,049
DWT 101	Overload	0,050	0,05
MBT 005	Overload	0,050	0,05
MBT 03	Overload	0,050	0,05
MBT 42	Overload	0,050	0,05

Handling the conditions that occur in this transformer is done by increasing the power capacity of the transformer. Thus reducing overload conditions on this transformer. The addition of this transformer is effective enough to reduce energy losses in distribution transformers as shown in the figure below.

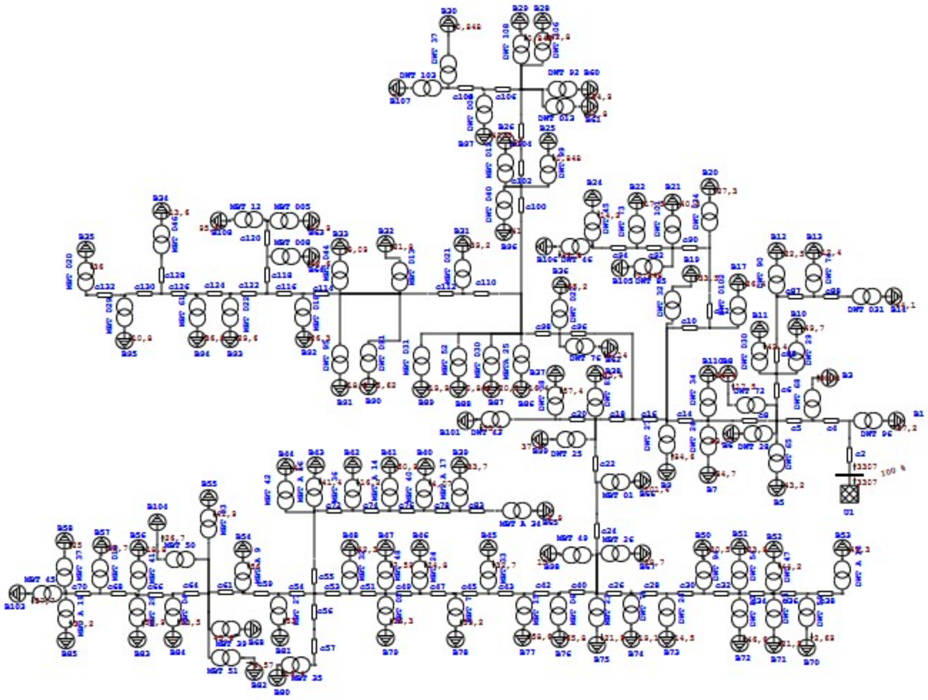

Fig. 7. Repair of overloaded transformers

Based on picture 7 above, it can be seen that no transformers are experiencing marginal or critical alert conditions. Reports or reports after distribution transformer repairs also reduce the value of power losses at the 05 Kreung Geukeuh Extension feeder as seen in table 4 below.

Table 4
Results of power loss correction on ETAP

Branch ID	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd % Drop in Vmag
	MW	Mvar	MW	Mvar	MW	Mvar	From	To	
MBT 005	-0.042	-0.026	0.042	0.026	0.2	0.2	98.7	99.1	0.49
MBT 12	0.096	0.060	-0.096	-0.059	0.5	0.5	99.1	98.6	0.55
MBT 046	0.014	0.008	-0.014	-0.008	0.0	0.0	99.1	98.8	0.31
MBT 020	0.036	0.022	-0.036	-0.022	0.1	0.1	99.1	98.7	0.42
DWT 45	0.014	0.009	-0.014	-0.009	0.0	0.0	99.5	99.1	0.33
DWT 96	-0.057	-0.035	0.058	0.036	0.3	0.3	99.3	100.0	0.66
c2	-3.306	-2.047	3.307	2.048	1.0	0.5	100.0	100.0	0.03
c90	0.116	0.072	-0.116	-0.072	0.0	0.0	99.5	99.5	0.01
DWT 034	0.027	0.017	-0.027	-0.017	0.1	0.1	99.5	98.9	0.63
DWT 101	-0.040	-0.025	0.040	0.025	0.2	0.2	99.0	99.5	0.47
c24	1.356	0.841	-1.355	-0.841	0.7	0.3	99.4	99.4	0.05

Energy losses in the extension of the ULP Kreung Geukueh feeder 05 are caused by the placement of distribution transformers of inappropriate capacity. This increases power losses on power lines. This was seen when improvements were made to the distribution transformer which was able to reduce power losses by 5kW. This change in improving power losses is illustrated when a simulation is carried out in MATLAB with a power loss value of 31.8 kW.

4. Conclusions

The technical shrinkage in the medium voltage network at feeder 05 ULP Kreung Geukeuh is simulated to be 31.6 kW in MATLAB and 41.8 kW in ETAP, mainly caused by the length of cable lines and insufficient capacity of distribution transformers. To overcome this, it is proposed to increase the conductor cross-section and capacity of distribution transformers. However, despite improvements, the five distribution transformers were still overloaded, contributing to increased power losses. Nevertheless, the overall loss is still below the 10% threshold specified by SPLN N0.72 1987, with a calculated power loss percentage of only 0.00081152% in ETAP and 0.10774% in MATLAB.

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