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Implementation Of Genetic Algorithm In Determining Point Of Connecting Power Supply For Beautiful Kiat Pulp And Paper (Ikkp) Substations To Gemini Feeder Substation Perawang Pt. Pln (Persero) Perawang Customer Service Unit

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Abstract: Increasing power demand and high load density makes power system operation more complicated. In the distribution of electricity to consumers that are located far apart, the system experiences an increase in power losses and a large voltage drop which results in low performance of the system. To achieve the goal of distributing electrical energy to the load by minimizing power losses and delivering quality electrical energy, a connection point is made to load from the feeder overloaded to the underloaded feeder. One of the Perawang GI feeders, the Gemini feeder, supplies electricity to the Mandau River sub-district, which is a distance of more than 100 km from the GI Perawang, causing a voltage drop and PT. PLN (Persero) Perawang ULP. Then determine the connection point of the system that aims to reduce losses, increase stability, increase the voltage profile through the Genetic Algorithm method found 3 possible connection points. The results of the proposed method, the existing condition found a voltage of 20.08 kV and power losses of 48 kW. After optimization found an optimal connecting point between Gemini feeder and GH IKPP, namely Recloser Inpress Bunut in Normaly Open (NO) with a voltage value of 19, 4 kV and distribution losses of 21 kW.

Keywords: Genetic Algorithms, Distribution Losses

1. Introduction

PT. PLN (Persero) ULP Perawang has 39,834 customers with sales of 77,738,365 kWh. Previously, PT. PLN (Persero) Perawang ULP has been supplied by Teluk Lembu Substation, but since July 2017, PT. PLN (Persero) Perawang ULP is supplied by Perawang Main Station. One of the Perawang GI feeders, the Gemini feeder, supplies electricity to the Mandau River sub-district, which is more than 100 km away from the GI Perawang, influenced by the length of conductor and the

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impedance value which is influenced by the resistance value and the reactance value of the channel, the greater the reactance value and the resistance value then causes the voltage drop and the distribution loss of PT. PLN (Persero) Perawang ULP increased. To minimize the voltage drop and distribution losses, the PLN UIW Riau and Riau Islands plan to increase supply from the Beautiful Kiat Pulp and Paper substation (GH IKPP) to Gemini feeders so that it is expected to minimize the voltage drop and the distribution shrinkage of PT. PLN (Persero) Perawang ULP between Gemini Feeders from GI Perawang and supply from GH IKPP strongly determines optimal voltage quality and Perawang ULP distribution losses. Therefore this paper discusses determining the connection point of the electricity supply voltage from GH IKPP to the Gemini GI Perawang Feeder.

2. Literature Review

In general, the merits of a power distribution and distribution system in terms of the quality of power received by consumers. Good power quality, including among others: the capacity to meet the power and voltage which is always constant and nominal. voltage must always be kept constant, especially the voltage losses that occur at the end of the line.

Reconfiguring power systems has always been considered a solution to improve power system performance from the last to the last few years. This problem has been widely investigated in electric power systems to get the results of the distribution of electrical energy to the load by minimizing power loss and delivering quality electrical energy by turning on or off the line. With the application of this system, financial losses and losses can be optimized by taking into account load factors, load locations, future developments, reliability and economic value.

2.1 Voltage drop

The voltage drop in the channel is the difference between the voltage at the base of the shipment and the voltage at the receiving end (Tanjung, 2014). Voltage reduction consists of two components:

I.Rs is the voltage losses caused by channel detention.

I.X1 is the voltage losses caused by the inductive reactance

The amount of voltage loss can be stated as follows (William D, 1984):

$$\Delta V = I\ R \cos\varphi + I\ X \sin\varphi \qquad (1)$$

$$\Delta V = I \times Z \qquad (2)$$

$$Z = \sqrt{R^2 + JX^2} \qquad (3)$$

Furthermore, the voltage formula and the voltage drop formula on the shipping side (Vs) are as follows (William D, 1984):

$$Vs = Vr + I\ R \times \cos\varphi + I\ X \sin\varphi \qquad (4)$$
$$= Vr + I \times Z$$

2.2 Power Losses

The energy lost in the distribution of electric power from the main electricity source to consumers is called power losses. In every distribution of electrical power to the load there are power losses caused by certain factors such as the distance of the power line to the load that is too far away, which can also result in increased resistance of the cable channel used. If time multiplied by power produces Energy while electric power is the multiplication of current and voltage, with Watt as the unit of electric power which represents the amount of electric power flowing per unit time (Joule / s). Voltage (V) in electric current (I) can produce electric power (P) expressed by the following equation (William D, 1984):

$$P = V \times I \qquad (5)$$

The amount of power losses in the distribution network can be written as follows (William D, 1984)

$\Delta P = \sqrt{3}.\ I^2.Z$ (Watt) (6)

The amount of power in the three-phase channel is (William D, 1984):

$\Delta P = \sqrt{3}.\ I^2.Z$ (Watt) (7)

2.3 Power Flow (Load Flow)

Study of power flow is the determination or calculation of voltage, current and power contained at various points of a network under normal operating conditions, both current and future. The power flow in this study is not specifically discussed and detailed, because it is only used as a study to determine the voltage profile and power losses that are used as a basis for selecting a connection point in a radial type power distribution network.

To solve the problem of power flow, various methods have been used, the most frequently used method as one of the basic materials for power flow studies is to form an admission matrix (Y) bus. Furthermore, the matrix is done by iteration, the basic method that will be discussed in this study is Newton Rapshon's method (Zulfahri, 2020).

In this method the power flow equation is formulated in polar form. The current that enters the bus i can be written with the following equation (in polar form).

$$\mathbf{I_1 = \sum_j^n |Y_{ij}||V_j| \llcorner \theta_{ij} + \delta_j} \quad (8)$$

The complex power on bus i is:

$$\mathbf{P_i^{\wedge} - j\, Q_i^{\wedge} = \quad V_i^{*}\, I_1} \quad (9)$$

From equations (1) and (2) we get the equation:

$$\mathbf{P_1 - jQ_i = |V_i| - \delta_1 \sum_j^n |Y_{ij}||V_j| \llcorner \theta_{ij} + \delta_j} \quad (10)$$

Or if the real and imaginary parts are separated

$$\mathbf{P_i = \sum_{j=1}^n |V_i||V_j|\,|Y_{ij}| \cos(\theta_{ij} - \delta_i - \delta_j)} \quad (11)$$

and

$$\mathbf{Q_i = \sum_{j=1}^n |V_i||V_j|\,|Y_{ij}| \sin(\theta_{ij} - \delta_i - \delta_j)} \quad (12)$$

Equations (11) and (12) form non-linear algebraic equations with their own variables. The magnitude of each variable is expressed in units per unit and for phase angles expressed in radial units. This method applies the Tailor series, as the basis for calculating iterations using Jacabian.

$$\begin{bmatrix} \Delta & P \\ \Delta & Q \end{bmatrix} = \begin{bmatrix} J_1 & J_2 \\ J_3 & J_4 \end{bmatrix} \begin{bmatrix} \Delta & \delta \\ \Delta & |V| \end{bmatrix} \quad (13)$$

The number of Jacabian matrix elements from equation (6) is determined by (2n - 2 - m) x (2n - 2 - m) where n is the number of buses in the system, while m is the number of Voltage-Controlled Buses in the system. The prices of $\Delta\, P_i^{(k)}$ and $\Delta\, Q_i^{(k)}$ differ between the scheduled and calculated values, and this is called the remaining power given by: New calculations for the phase angle and bus voltage are:

$$\delta_i^{(k+1)} = V_i^{(k)} + \Delta\, \delta_i^k \quad (14)$$

$$V_i^{(k+1)} = \left|V_i^{(k)}\right| + \Delta \left|V_i^{(k)}\right| \quad (15)$$

2.4 Algoritma Genetika

Genetic Algorithm is an algorithm search method based on natural and genetic selection mechanics (Zulfahri, 2020). In the Genetic Algorithm method, there is a group of individuals (called populations) for a problem - in this case the calculation of power flow is expressed in the form of real numbers, which make up the chromosome-forming genes. The population is formed from random generation and subsequently selected through a Genetic surgery procedure consisting of Selection, Crossover, Mutation. The results of the mutation are evaluated using the fitness function to determine which selected chromosome is included in the looping process until it reaches the desired value while stopping the loop at a certain value at a predetermined stop criterion (can be a certain value or a certain generation). The AG process follows the following rules [Zulfahri 2020].

- Specify population initials (usually strings are randomly generated) Evaluate all individuals (apply several functions or individual formulas)
- Select a new population from the initial population based on the fitness value of the individual given by the evaluation function.
- Apply genetic operators such as mutase and crossing each member of the population to get a new solution. New individual evaluations are formed.
- Repeat steps 3-6 (one generation) until the termination criteria are satisfied (usually in the form of a specific generation number.

3. Methodology

3.1 Time and place

The study was conducted at PT. PLN (Persero) UP3 Pekanbaru ULP Perawang located on Jalan M. Ali No 105, Kelurahan Perawang Barat, Tualang District, Siak Sri Indrapura Regency. Data is collected at a medium voltage of 20 kV on the Gemini feeder.

3.2 Research Design

This study uses a qualitative design. accompanied by field data analysis assistance for to see the existing condition of the channel from the voltage profile through the power flow for prediction of voltage losses, power losses as well as energy development and future system planning.

3.3 Research Stages

The preparatory stage at this stage is the initial data collection as well as the process of approaching the research object and preparing research support references. The initial data needed is:

- Literature study is the activity of writing to look for sources of reference and collect necessary data.
- Channel data input is changing all data in units per unit.
- Determination of the connecting point using the Genetic Algorithm method via Newton Rapshon power flow is a simulation that is run using the help of Matlab R2016a software
- Comparing the results of power losses and voltage profiles so that the optimal connection point is found in minimizing power loss.

4. Result and Discussion

The distance of the channel between GI Perawang to GH IKPP is 40 km. The distance between GH IKPP and Mandau River District is closer than the distance between Perawang GI and Mandau District. If the Mandau River District is supplied from GH IKPP, it will minimize Perawang ULP distribution losses. Furthermore, the data collected is in the form of a single line diagram of a Gemini feeder. In the feeder there are 6 section switches as shown in Figure 1.

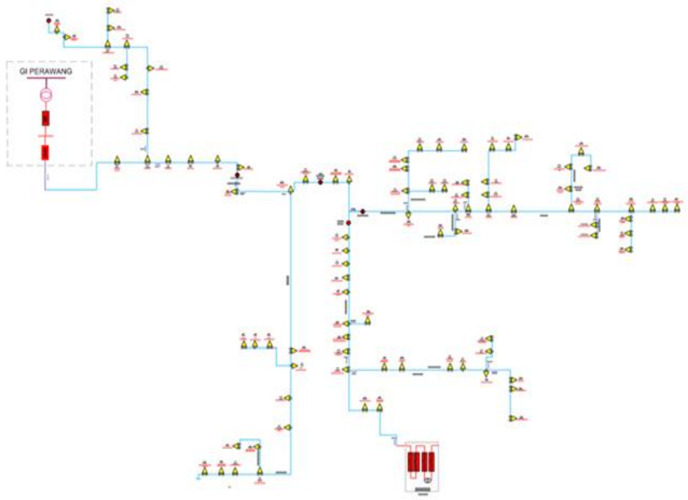

Figure 1: Single Line Gemini Feeder Diagram

Gemini feeders are supplied with 150 mm2 and 240 mm2 types of All Alloy Aluminum Conductor (AAAC) conductors.

Table 1:Hold R and X of the Gemini Feeder cable

Bus Awal	Bus Akhir	Area (mm^2)	Distance (km)	Z (Ohm)	Bus Awal	Bus Akhir	Area (mm^2)	Distance (km)	Z (Ohm)
1	2	240	1,45	0,497654	16	17	150	1,3	0,513414
2	3	150	1,55	0,612147	17	18	150	1,8	0,710881
3	4	150	2,3	0,908348	18	19	150	1,4	0,552907
4	5	150	1,3	0,513414	19	20	150	1,6	0,631894
5	6	150	3,8	1,500748	20	21	150	0,77	0,304099
6	7	150	2,3	0,908348	21	22	150	0,55	0,217214
7	8	150	5,3	2,093149	22	23	150	0,25	0,098733
8	9	150	0,05	0,019747	23	24	150	0,25	0,098733
7	10	150	4,25	1,678469	24	25	150	0,85	0,335694
10	11	150	1,7	0,671387	25	26	150	0,6	0,23696
11	12	150	1,5	0,592401	26	27	150	0,2	0,078987
10	13	150	8,25	3,258204	27	28	150	0,45	0,17772
13	14	150	0,95	0,375187	28	29	150	0,45	0,17772
3	15	150	0,5	0,197467					
15	16	150	1,7	0,671387	82	83	150	0,3	0,11848
16	17	150	1,3	0,513414	83	84	150	1,65	0,651641
17	18	150	1,8	0,710881	84	85	150	0,75	0,2962

Distribution transformer used at PT. PLN (Persero) Perawang ULP is a 3 phase transformer, the following is a transformer data table and the load of each transformer on Gemini Feeder Perawang Perawang Main Table 2:

Table 2: Loads of Gemini Feeder Transformers

No Bus	Gardu	Kapasitas (kVA)	Load (kVA)	No Bus	Gardu	Kapasitas (kVA)	Load (kVA)
2	PRW 076	50	33,53	19	PRW 089	160	27,22
3	PRW 012	100	75,25	20	PRW 137	200	21,26
4	PRW 085	100	30,39	21	PRW 141	100	27,83
5	PRW 086	100	50,58	22	BNT 013	50	17,38
6	PRW 148	100	6,22	23	BNT 014	200	105,62
7	PRW 087	100	46,83	24	BNT 015	50	21,26
8	PRW 095	100	24,43	25	BNT 016	100	54,13
9	PRW 107	50	1,23	26	PRW 114	25	8,77
10	PRW 088	100	25,86				
11	PRW 149	100	2,98	88	PRW 215	50	12,93
12	PRW 176	160	46,68	89	PRW 156	100	31,12
13	PRW 101	25	6,57	90	PRW 199	50	30,68
14	PRW 102	25	5,65	91	PRW 197	50	30,02
15	PRW 011	50	35,17	92	PRW 198	50	28,93
16	PRW 010	50	10,41	93	PRW 208	50	32,61
17	PRW 098	50	17,57	94	PRW 200	50	20,16
18	PRW 104	50	8,57	95	PRW 201	50	24,98

4.1 Network connection point method

The Gemini feeder has 4 section switches that can be changed to the Normaly Open (NO) condition. The four section switches are Alfamart Recloser, Inpress Bunut Load Break Switch (LBS), Mandau Recloser and Kampung Tengah Load Break Switch (LBS). In the existing condition all switches are connected. Because GH IKPP will supply Gemini feeders, and the network has 4 section switches, the connection points to be made are 3 types. The first condition is an existing condition so that on the connecting point map plan there are 3 types that will be performed using the algorithm genetic method. The form of the specified connection point map is as follows:

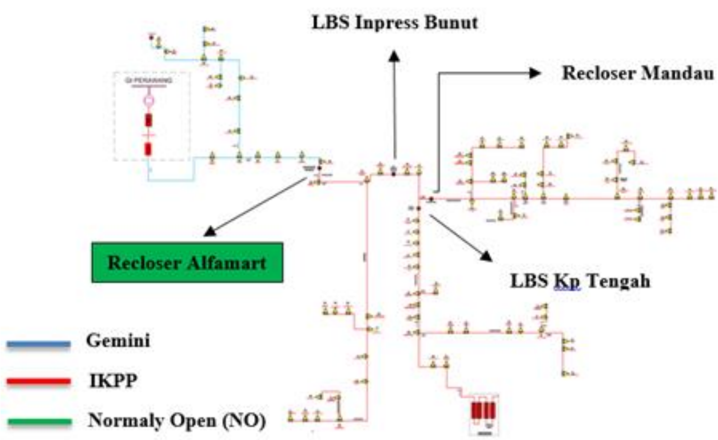

Figure 2: Connecting point shape one

In the type of reconfiguration one, GH IKPP also supplies the Gemini feeder, the section switch that breaks the two feeders is the Alfamart Recloser. In this type of reconfiguration, the Gemini feeder has a channel length of 40kms and a load of 0.3637 m while IKPP has a channel length of 208.12 kms and a load of 2.04 mW.

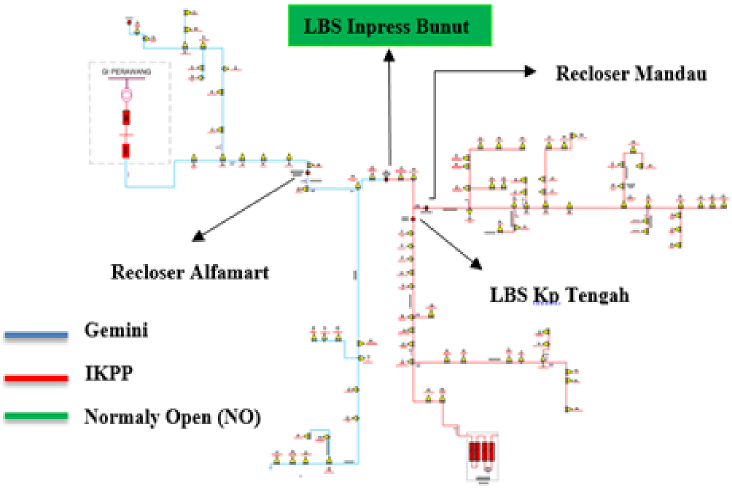

Figure 3:Form of a double join

In the second type of reconfiguration, the section switch that breaks the two feeders is the LBS Inpress Bunut. In this second type of reconfiguration the Gemini feeder has a channel length of 49.07 kms and a load of 0.9052 MW while IKPP has a channel length of 199.05 kms and a load of 1,5011 MW.

In the third type of reconfiguration, the section switch that breaks the two feeders is the Central Village LBS. In this third type of reconfiguration, the Gemini feeder has a channel length of 232.77 kms and a load of 0.9262 MW while IKPP has a channel length of 16.5 kms and a load of 1.777 MW. After the selection process is carried out using the genetic algorithm method through the Newton Raphson method power flow with the help of Matlab R2016a software, the results are as shown in Figure 5 and 6:

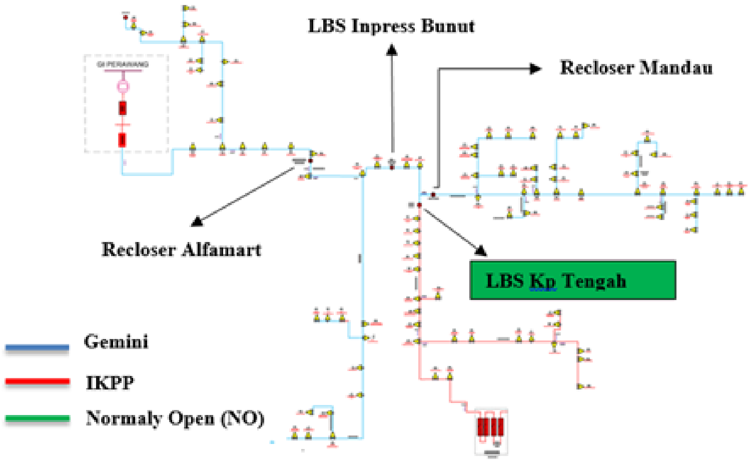

Figure 4: Three-point shape

In the third type of reconfiguration, the section switch that breaks the two feeders is the Central Village LBS. In this third type of reconfiguration, the Gemini feeder has a channel length of 232.77 kms and a load of 0.9262 MW while IKPP has a channel length of 16.5 kms and a load of 1.777 MW. After the selection process is carried out using the genetic algorithm method through the Newton Raphson method power flow with the help of Matlab R2016a software, the results are as shown in Figure 5 and 6:

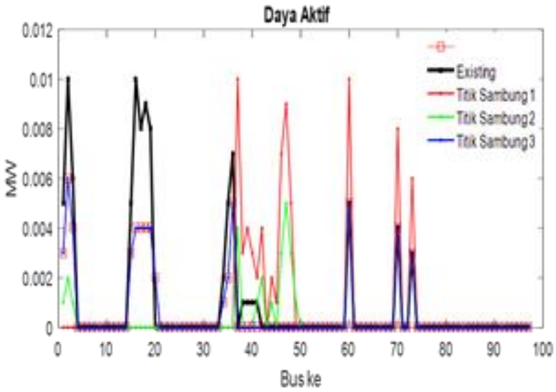

Figure 5 Active power repair at the connection point

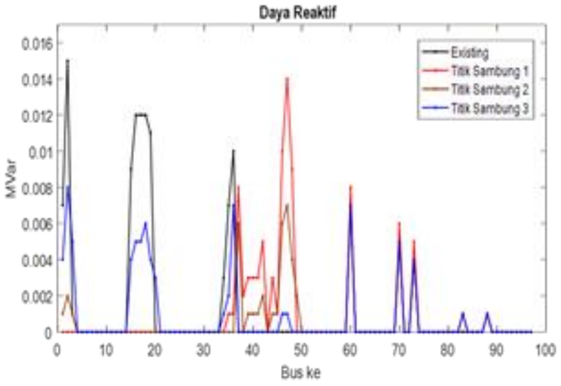

Figure 6. Repair of Reactive power at the connection point.

Showing the graph of losses at each connecting point Existing conditions found 48 kW power losses, the condition of the first connecting point of 40 kW, the condition of the second joint point of 21 kW and the condition of the third joint point of 27 kW as shown in Figure 5. While the reactive power Losses are shown in the picture 6 graphs of losses at each connecting point Existing condition found power losses of 72 KVar, the condition of the first connection point of 47 KVar, the condition of the second connection point of 32 KVar.

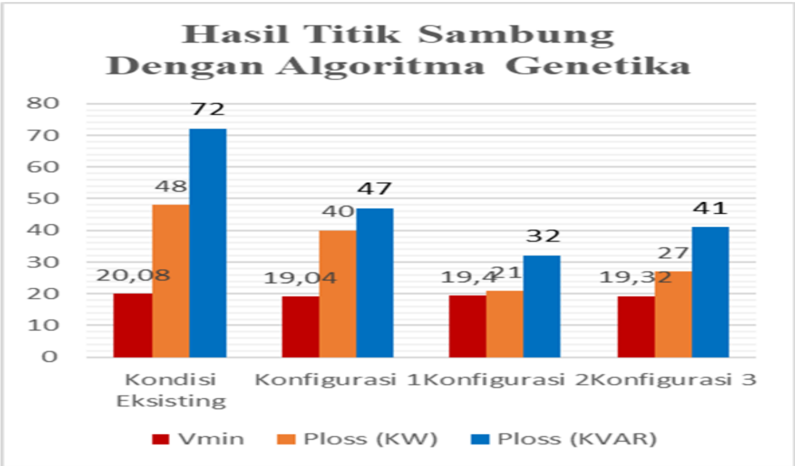

Figure 7: Results of connecting points with matlab

From the simulation results shown in Figure 7 shows that:

- Existing Condition is a condition where GH IKPP has not supplied Gemini feeder, in this reconfiguration the lowest working voltage is 20.08 kV and power losses are 48 kW.
- Configuration 1 is the connecting point condition where Alfamart Recloser is in Normaly Open position, in this reconfiguration the lowest working voltage is 19.04 kV and power losses are 40 kW.
- Configuration 2 is the connecting point condition where the LBS Inpress Bunut is in the Normaly Open position, in this reconfiguration the lowest working voltage is 19.4 kV and the power losses are 21 kW.
- Configuration 3 is a connecting point condition where LBS Kampung Tengah is in Normaly Open position, in this reconfiguration the lowest working voltage is 19.32 kV and power losses are 27 kW.

5. Conclusion

Based on observations and analysis of research on the Beautiful Kiat Pulp substation and paper (IKKP) to the feeder gemini substation perawang perawang PT. PLN (Persero) perawang customer service units found the following conclusions:

- The distribution stress and shrinkage in Gemini feeders before GH IKPP is 20.08 kV and 48 kW. The optimal connecting point between Gemini feeder and GH IKPP to minimize voltage drop and distribution loss is Recloser Inpress Bunut in Normally Open (NO) condition.
- Voltage drop and Shrink distribution after GH IKPP supply is 19.4 kV power loss is 21 kW and 32 KVar

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