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Network Reconfiguration of 20 kV Sample Connection Substance LG-04 Lhokseumawe City Using Digsilent Power Factory Software Simulation 15.1

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ABSTRACT

In this final project, we describe the study of reconfiguring the distribution network at the LG-04 feeder at the Lancang Garam substation, Lhokseumawe, to improve the performance of the distribution system. The focus of the parameters considered includes continuity, voltage, and power loss. The reconfiguration is to change the initial network topology which is in the form of radial into a loop. After reconfiguration, the calculation of power flow, voltage drop, power loss, and short circuit calculation is also carried out which becomes a reference for whether or not the quality of the network is good. The results of the simulation of the existing conditions show that continuity is not good, after reconfiguration and fault testing, the network does not experience blackouts like the network before reconfiguration. The power loss generated in the network after reconfiguration is 0.507 kW or a decrease of ±84% from the previous form of the network.

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1. INTRODUCTION

Distribution of electrical energy must have optimal distribution quality, both in terms of reliability and in terms of continuity. The selection of the right type of network configuration greatly affects how the quality of the distribution of electrical energy is distributed [1] [2]. In general, the configuration used in the distribution network is a radial configuration which is the basic and simplest form, and the investment costs are relatively cheaper than other types of configurations [3]. One of the feeders that uses a radial configuration is the LG-04 feeder, which is one of the feeders from the Lancang Garam Substation.

LG-04 feeders that have important loads, such as Sakinah Hospital, Lhokseumawe City RRI radio, and several other important loads, must receive special attention where the received power supply must be reliable and continuous [4]. Facts on the ground show that the electricity supply received by Sakinah Hospital only comes from one line, namely through the inlet from BS-139. This causes if there is a disturbance in the LG-04 feeder, the electricity received by the hospital will go out. In fact, given the current situation of the COVID-19 pandemic, health services must run optimally, of course, it requires a good electricity supply. In addition, the power supply for information and communication facilities such as RRI must also be optimal.

The problems above indicate that research is needed on the installation of new channels in this feeder. Installation can be done by connecting the feeder end of the LG-04 with another feeder that has a lighter load. Field data indicates that the LG-02 feeder is a suitable feeder to connect to the LG-04. The connection of these two feeders can be done at each end of the load on the two feeders located on the Tumpok Teungoh village electricity road [5].

2. RESEARCH METHOD

2.1. Distribution System

Electric power distribution systems can be divided into two types, namely Direct Distribution and Indirect Distribution [6] [7]. The direct distribution system is a system of distributing electric power directly from the generator without going through the transmission network first. Usually used if the generator is located not far from the load, usually located on the outskirts of the city or load service area [8]. While the indirect distribution system is an electric power distribution system whose power plant center is far from the load center, it must go through a transmission network first before being connected to a distribution network that directly distributes power to the load [9] [10].

2.2. Radial Network

The radial system is a simple primary distribution network with low investment costs [11]. This type is less reliable in its distribution [12] because if there is a disturbance in the feeder it will cause blackouts in the next stream.

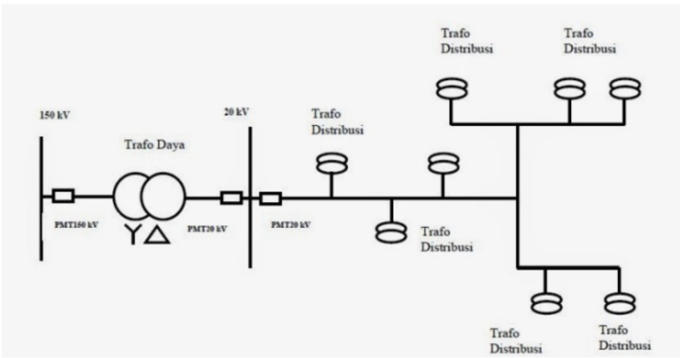

Figure 1. Radial Circuit

2.3. Loop Network

This type is a combination of two radial networks [13], where the ends of the two networks are installed with PMT [14]. Under normal conditions this type works radially, when losses occur, the PMT can be operated so that the disturbances that occur can be localized. Although this type is more reliable than the radial type, the investment cost is more expensive because more components are needed, and the controls and systems are also more complicated.

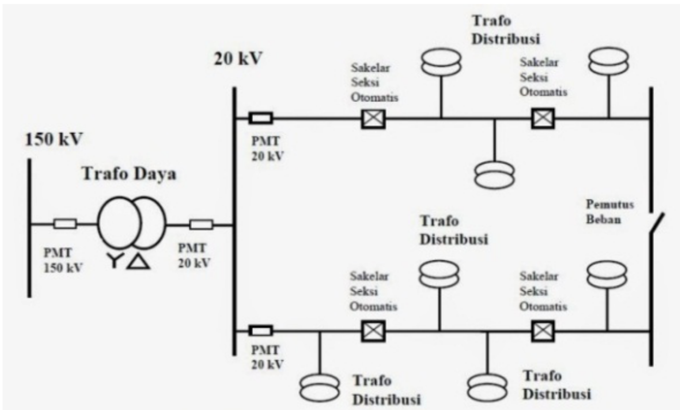

Figure 2. Loop Circuit

2.4. Distribution Network Delivery

Conductor wire is the material used to transmit electric power [15] to the overhead line system from the Generating Center to the Load Center, either directly using the distribution network or the transmission network first.

a. AAAC (All Allumunium Aloy Conductor) is a cable having a conductor core made of a non-insulating aluminum alloy
b. ACSR (Allumunium Conductor Steel Reinforced) is a cable with aluminum core with steel tape sheath.
c. ACAR (Allumunium Conductor Aloy Reinforced) is an aluminum cored cable with a metal alloy sheath.

In determining the cross-sectional area, the amount of current that will pass through a conductor must be calculated [16]. So to find out how much current is produced, calculations using Ohm's law are used as in the following equation [17]

3. RESULTS AND DISCUSSION

In this section, it is explained the results of research and at the same time is given the comprehensive discussion. Results can be presented in figures, graphs, tables and others that make the reader understand easily. The discussion can be made in several sub-chapters.

3.1. Existing Condition Before Reconfiguration

The following is the SLD of the LG04 feeder at the Lancang Garam substation in the existing condition.

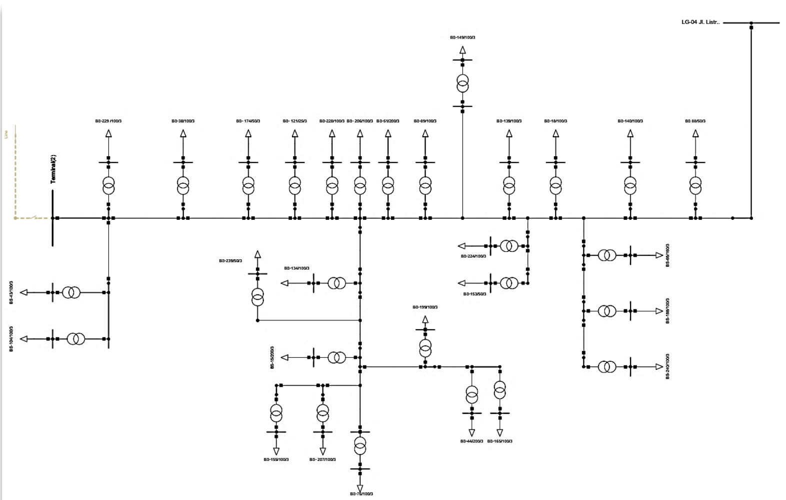

Figure 3. SLD network existing condition

The losses incurred on the network can be seen in the calculation [18] [19] below. For example, the calculation is carried out on the line from bus1 to the BS88.

Active power loss on line per Phase

$$P_{Loss1\phi} = I^2 \, x \, R$$
$$= (41)^2 \, x \; 0,02745$$
$$= 1681 \, x \, 0,02745$$
$$= 0,461 \; kW$$

Active power loss on 3Phases line

$P_{Loss3\phi} = 3 \times P_{Loss1\phi}$

$= 3 \times 0{,}461\ kW$

$= 0{,}138\ kW$

The following is the loss value calculated by the DigSILENT PowerFactory simulation software with a radial network topology [20] [21].

Table 1. Loss of Data under existing conditions

CHANNEL	CURRENT (kA)	LOSSES (kW)
Terminal1-BS88	0,034	0,138
BS88-BS140	0,034	0,087
BS140-Terminal2	0,033	0,083
Terminal2-BS18	0,029	0,095
BS18-Terminal3	0,027	0,028
Terminal3-BS139	0,026	0,026
BS139-Terminal4	0,025	0,069
Terminal4-BS149	0,002	0,0003
Terminal4-BS89	0,024	0,060
BS89-BS51	0,022	0,086
BS51-BS206	0,021	0,0145
BS206-BS228	0,007	0,001
BS228-BS121	0,005	0,0006
BS121-BS174	0,005	0,0013
BS174-BS38	0,004	0,001
BS38-BS229	0,003	0,0003
Terminal2-BS65	0,005	0,058
BS65-BS188	0,001	0,006
BS188-BS240	0,001	0,0001
Terminal3-BS224	0,001	0,00003
BS224-BS153	0	0,00005
BS206-BS134	0,017	0,032
BS134-Terminal5	0,016	0,008
Terminal5-BS239	0,001	0,0001
Terminal5-BS15	0,015	0,003
BS15-BS199	0,008	0,002
BS199-BS44//165	0,01	0,001
BS15-Terminal6	0,004	0,001
Terminal6-BS207	0,001	0,00003
BS207-BS155	0,001	0,0001
Terminal6-BS76	0,003	0,002
BS229-BS43//104	0,002	0,0008
Total		**1,444**

It can be seen from Table 4.2 that the power losses in the LG04 network are 1.444 kW. Power losses occur due to the influence of several things, including the amount of current flowing in the conductor, where the current flowing in the conductor causes heat in the conductor wire that causes power loss in the network. In addition, the conductor distance and cross-sectional area also affect the resulting power loss.

3.2. Network Continuity Before Recon-figuration

When a load shedding simulation is carried out on the LG-04 busbar, there will be blackouts on all loads on the network because the power is not supplied. The occurrence of blackouts in the net causes all voltages on all loads to have a value of 0.

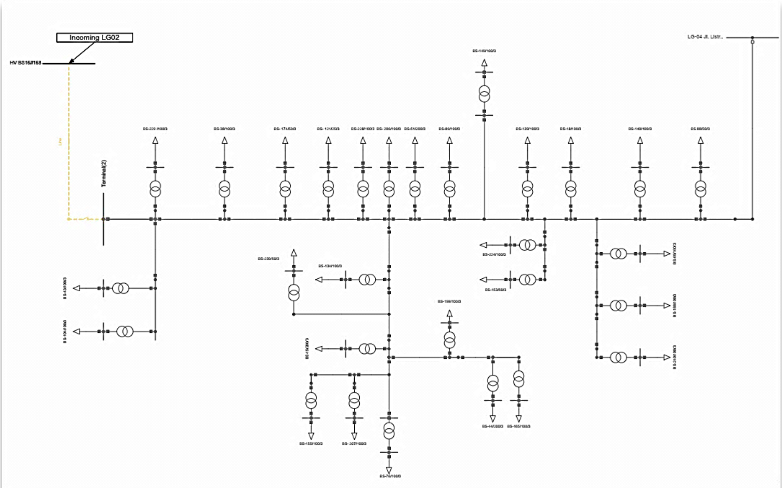

Figure 4. Network Continuity Before Reconfiguration

Based on real conditions in the field, it takes a long time to restore conditions to their original state, with all loads being able to receive power, considering that the line does not have a backup source. So it can be said that the continuity of the system is not good because if a system has good continuity, it means that the system can minimize blackouts.

3.3. LG-02 Feeder Existing Condition

The LG-02 feeder is located on Jalan Darussalam which has a length of ± 3.65 km and serves about 20 units of load. This feeder was chosen to be connected due to the location of the end of the channel adjacent to the end of the LG-04 channel which is located in the village of Hagu Teungoh, precisely around the ex PLTD Hagu. The following in Figure 4.3 shows the Single Line Diagram of the LG-02 feeder in the existing condition.

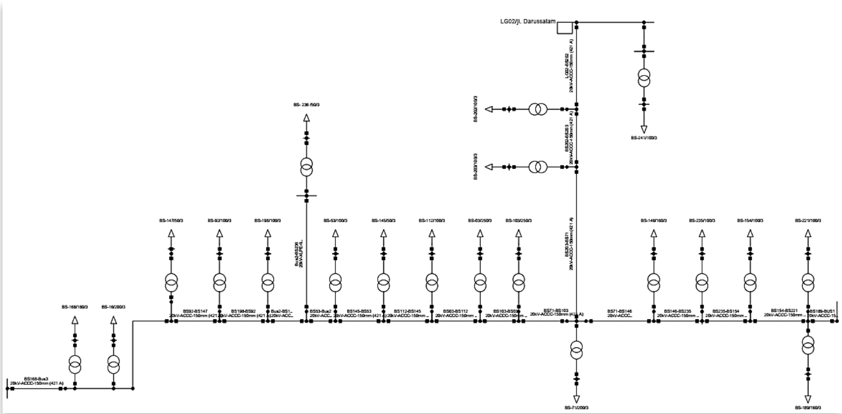

Figure 5. LG04 feeder existing condition at DigSILENT PowerFactory Software

The following is the load and voltage data generated on the LG-02 line shown in Table 2.

Table 2. LG-02Loss of Data under existing conditions

CHANNEL	CURRENT (kA)	LOSSES (Kw)
LG02-BS241	0.001	0.00005
LG02-BS202	0.03	0.05
BS202-BS203	0.03	0.05
BS203-BS71	0.029	0,046
BS71-BS146	0.006	0.002

BS146-BS235	0.004	0.0004
BS235-BS154	0.004	0.0008
BS154-BS221	0.029	0.046
BS71-BS103	0.02	0.03
BS103-BS03	0.016	0.014
BS03-BS112	0.012	0.008
BS112-BS145	0.01	0.003
BS145-BS53	0.009	0.002
BS53-Bus2	0.008	0.002
Bus2-BS236	0.0005	0.00003
Bus2-BS198	0.008	0.005
BS198-BS92	0.007	0.0027
BS92-BS147	0.005	0.001
BS147-BS16	0.004	0.013
Total		**0,280**

3.4. Network Condition After Reconfiguring

The following is the SLD of the LG04 feeder at the Lancang Garam substation in the existing condition.

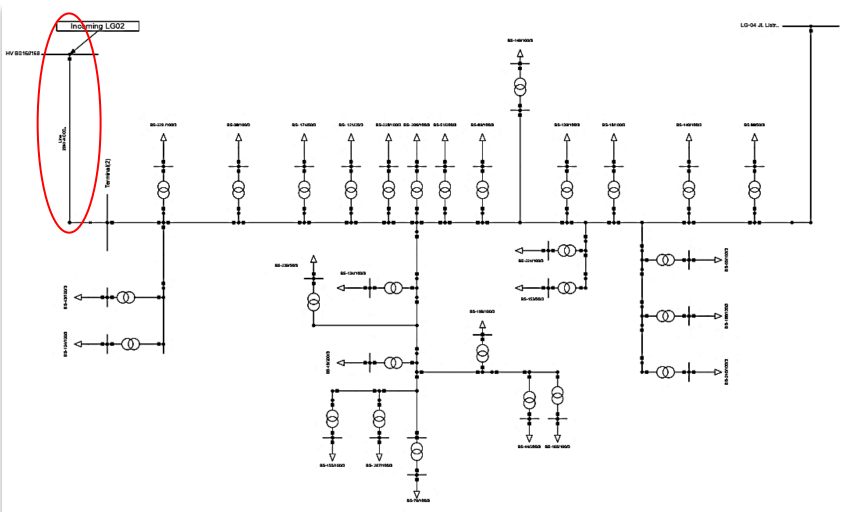

Figure 6. Figure Network After Reconfiguration

3.5. Calculation and Determination of the Type of Carrier

To determine the cross-sectional area of the cable, it is necessary to calculate the amount of current generated by calculating the power used between the load bus BS-229 to BS-16 of 110 kW.

$$I_n = \frac{P}{\sqrt{3}xVxCos\varphi}$$

$$\text{KHA} = I_n x\ 125\%$$

$$= \frac{110\ kW}{\sqrt{3}x400x0{,}8}$$

$$= \frac{110.000}{554}$$

$$= 198{,}5\ A\ x\ 125\%$$

$$= 248{,}19\ A$$

The following are the losses generated on the network after reconfiguration can be seen in the table below

Table 3. Total Losses After Reconfiguration

UNIT	CURRENT (kA)	LOSSES (Kw)
Terminal1-BS88	0,031	0,080
BS88-BS140	0,04	0,087
BS140-Terminal2	0,019	0,019
Terminal2-BS18	0,024	0,047
BS18-Terminal3	0,022	0,013
Terminal3-BS139	0,021	0,012
BS139-Terminal4	0,019	0,028
Terminal4-BS149	0,002	0,0003
Terminal4-BS89	0,017	0,023
BS89-BS51	0,025	0,085
BS51-BS206	0,023	0,014
BS206-BS228	0,003	0,0002
BS228-BS121	0,005	0,0007
BS121-BS174	0,005	0,001
BS174-BS38	0,006	0,002
BS38-BS229	0,003	0,0002
BS299-Terminal(2)	0,01	0,008
Terminal2-BS65	0,005	0,006
BS65-BS188	0,001	0,0002
BS188-BS240	0,001	0,0001
Terminal3-BS224	0,001	0,00003
BS224-BS153	0,0005	0,00005
BS206-BS134	0,014	0,032
BS134-Terminal5	0,012	0,008
Terminal5-BS239	0,001	0,0001
Terminal5-BS15	0,011	0,003
BS15-BS199	0,004	0,003
BS199-BS44//165	0,003	0,0007
BS15-Terminal6	0,004	0,0006
Terminal6-BS207	0,001	0,00004
BS207-BS155	0,001	0,0001
Terminal6-BS76	0,003	0,002
BS229-BS43//104	0,002	0,0008
BS229-BS16	0,01	0,008
Total		**1,184**

Based on Table 3, it can be seen that the total power loss is 1.34 kW. The value of this power loss is caused by the influence of the value of the current flowing in a conductor, where the current causes heat in the conductor which is the cause of the losses. So, the bigger the current, the bigger the power loss.

3.6. Network Continuity After Reconfiguration

To see how the continuity of the distribution can be done with an open circuit scenario or cut off the flow of power in the network, which is tested on simulation software as shown in Figure 7 below.

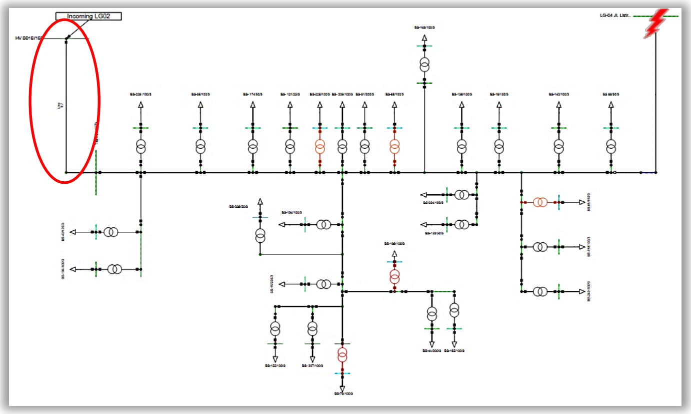

Figure 7. Simulated Blackout on Feeder LG-04

It can be seen in the picture, when the line that supplies power to the network is removed, the power supply will be backed up through a new line that has been connected to the LG-02 feeder so that the loads in this area do not experience blackouts. Table 4 below is the voltage generated on the simulation.

Table 4. Losses After Reconfiguration

Load	Voltage (kV)
BS 88/50/3	19,94
BS-140/100/3	19,94
BS-18/100/3	19,94
BS-139/100/3	19,94
BS-149/100/3	19,94
BS-89/100/3	19,94
BS-51/200/3	19,94
BS- 206/100/3	19,94
BS-228/100/3	19,94
BS- 121/25/3	19,94
BS- 174/50/3	19,94
BS-38/100/3	19,95
BS-229 /100/3	19,95
BS-65/160/3	19,94
BS-188/100/3	19,94
BS-240/100/3	19,94
BS-224/100/3	19,94
BS-153/50/3	19,94
BS-134/100/3	19,94
BS-239/50/3	19,94
BS-15/200/3	19,94
BS-199/100/3	19,94
BS-44/200/3	19,94
BS-165/100/3	19,94
BS-76/100/3	19,94
BS- 207/100/3	19,94
BS-155/100/3	19,94
BS-43/100/3	19,95
BS-104/100/3	19,95

After carrying out the load shedding scenario, several voltage differences were found on the primary side. This is because when the conductor is opened, the load bus status changes from “In” to “Out” and vice versa, so that the ends of the conductors can change.

4. CONCLUSION

Based on the simulation results of network reconfiguration on the LG04 feeder at the Lancang Garam Substation, the following conclusions are obtained.

1. The simulation results of the existing condition network show that the quality of electricity distribution is still fairly good, because the amount of losses that occur is still within the SPLN 72:1987 standard. Point, then the loads that follow will also be affected by disturbances.

2. In the network after reconfiguration in the form of a loop, the quality of energy distribution is better because the energy is channeled in two directions where there is a power reserve in case of a disturbance so that the continuity of distribution is better.kW. While the LG -02 feeder is 4.85 kW to 0.65 kW.

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