Analysis of Distribution Network Planning and Load Development at Izzara Mansion Housing Jati Kesuma Village Namorambe

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Abstract

Planning in this study aims to obtain an optimal service flexibility so as to anticipate the rapid growth of electrical energy and how dense the load must be served. So that in planning the electric power distribution network system must pay attention to load conditions in the field, this is intended so that the planned distribution network system can still work properly for the next few years. The data collection method used is field observation which aims to determine field conditions and obtain load data to be planned. The results of research conducted at the Izzara Mansion housing complex located in Jati Kesuma Village, Namorambe Sub-District, Deli Serdang Regency, North Sumatra show that there are 68 housing units to be built in this housing complex. A total of 68 housing units will be divided into 3 blocks A, B, C and planned with an initial power of 2200 VA for each housing unit. By paying attention to field conditions, ground cables are used as a distribution network system which includes Medium Voltage Cable Lines (SKTM) and Low Voltage Cable Lines (SKTR). From the calculation, it is obtained that the total power obtained is 149,600 VA served by 1 distribution transformer unit using a pole transformer substation with a power of 200 kVA. in this planning there has been no additional load or housing units in the area because it is the final stage of housing development, so to overcome the development of housing, namely by determining a transformer with an additional 20% which is useful for backup power as a form of anticipation in the event of load growth in the housing.

Keywords: ***Distribution Network Planning, Load Development***

Introduction

Izzara Mansion Housing is a new housing development located in Jati Kesuma Village, Namorambe District, Deli Serdang Regency. Because it is a new housing development, the availability of electricity resources to meet the load needs in Izzara Mansion Housing is not fully available so that the electricity distribution network system planning is needed to fulfill this. In addition, the current trend, the increase in electrical energy is not in line with the increase in the supply of electrical energy, where the installed power capacity is still fixed, while the needs of the community continue to increase along with the increasing number of residents and resident activities. The imbalance of demand and availability of electrical energy sources leads to frequent power outages, especially during peak load hours, which is due to the usage load exceeding the available power. This condition requires the development of electricity supply in the coming years. Therefore, the need for planning aimed at obtaining flexibility in the growth of electrical energy and how dense the load must be served

Literature Review

2.1 Power Distribution System

The electric power network system is the distribution of electricity from the power station to the consumer (user) at the required voltage level. This power system consists of generating units, transmission units, and distribution units.

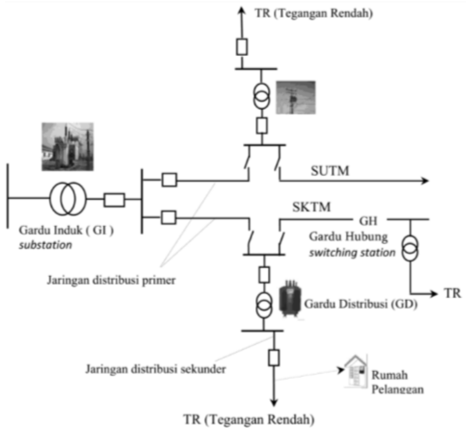

Figure 1. Single Chart of Distribution Network System

2.2 Distribution Substation

Distribution substation is one of the components of the distribution system that serves to connect the network to consumers or distribute electricity to loads (medium voltage consumers and low voltage consumers) either through overhead lines or underground channels. The distribution transformer serves to reduce the voltage from the high voltage distribution network to the voltage used in the low voltage distribution network.

2.3 Transformers

Distribution transformers are used to reduce the voltage of electricity from high-voltage distribution networks to the voltage used in low-voltage distribution networks (step down transformers), for example 20 KV voltage to 380 Volt or 220 Volt voltage. While the transformer used to increase the voltage (step up transformer) is only used in power plant centers so that the voltage supplied on long lines does not experience a significant voltage drop, which does not exceed the allowable voltage drop of 5% of the original voltage.

To determine the transformer capacity, it is necessary to know the total installed power and pay attention to the development factor so that the transformer can be loaded 100% of the maximum load. Then the total power is multiplied by 120% where 20% is reserve power which aims to handle in the event of load development so there is no need to replace the new transforme.

Installed power capacity = S_{Total} x 120% (1)

Where:
S_{Total} = Total installed load power
120% = Percentage of backup power

2.4 Switching Panel

A device for distributing electrical power and/or controlling and protecting electrical circuits and users including circuit breakers, low voltage electrical panels and the like. Where the whole is assembled completely with cables and mechanical systems in the supporting parts.

2.5 Underground Cable Channel

The ground cable is one / several wires that are insulated, so that they are resistant to certain voltages between one conductor and another conductor or conductor with the ground wrapped in a protective layer, so that they are protected from other chemical influences in the soil, therefore components including cables must be able to operate in the ground, therefore components including cables must be able to operate continuously because they have special insulation requirements to protect them from all forms of moisture and other influences in the soil. To determine the conductor, namely by first knowing the nominal current in the following way:

$$In = \frac{S}{\sqrt{3}\, x V} \qquad (2)$$

After knowing the nominal current, determine I $_{KHA}$ which is in the following way:

$$I_{KHA}\ x\, In\, x 125\% \qquad (3)$$

Where:
In = Nominal Current
S = Installed Power
V = Voltage
I_{KHA} = Current Conductivity

2.6 Drop Voltage

Drop Voltage is the amount of voltage lost on a conductor. Voltage drop on power lines is generally directly proportional to the length of the line and load and inversely proportional to the cross-sectional area of the conductor. The amount of Drop Voltage is expressed in units of % or Volts.

2.7 Electricity Load Forecasting

Electricity demand in an area depends on the location of the area, population, standard of living, development plans or future development of the area. Improper forecasting of electricity demand can lead to insufficient capacity provided to serve consumers and vice versa, if forecasting is too large than demand, there will be excess power capacity which is a waste. Therefore, errors in forecasting should be kept to a minimum.

Research Methodology

3.1 Time and Place of Research

This research was conducted at Izzara Mansion Housing located in Jati Kesuma Village, Namorambe District, Deli Serdang Regency, North Sumatra which is still under construction so there is no electricity distribution in the residential area. The research implementation period began in June 2025.

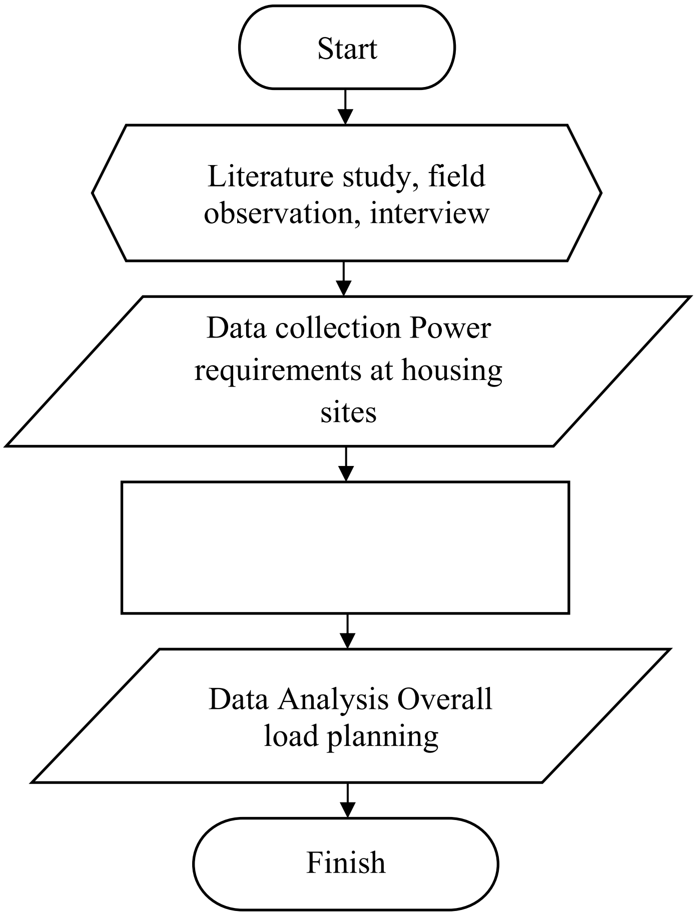

Figure 2. Flowchart of Research

3.2 Data Collection

To design a distribution network that uses underground cables, it is necessary to collect data obtained by observing the location where the project is carried out. The data obtained is in the form of a plan where the housing area is 120000 m2 and 68 housing units will be planned with different types in each house. Each house will be planned with an initial power of 2200 VA so that the total planned power is 149,600 VA.

3.3 Research Series

Izzara Mansion Housing, which is located in Jati Kesuma Village, Namorambe District, Deli Serdang Regency, North Sumatra, will be divided into several blocks, starting from block A to block C. The electric power for each housing unit is planned to use 2200 VA. For the electrical system in this housing is planned to use a ground cable channel with a Pole Transformer Substation. While residential roads are generally two-way, in this planning the type of lamppost that will be used is a single arm lamppost, the position of the lamppost will be placed on the road media.

Table 1. Phase Division

Phase Division	Housing Blocks	Number of Houses	Power/Home	Total Power (Watt)
R	A	23	2200	50.600
S	B	23	2200	50.600
T	C	22	2200	48.400
Total		**68**		**149.600**

3.4 Transformer Selection in Housing

Installed power capacity = Total power (S_{Total}) 20% Reserve
Installed power capacity = S_{Max} x 120% (4)
Installed power capacity of pole transformer substation

=149.600 VA x 120%
=179.520 VA

The total load to be supplied is 179,520 VA, so a transformer will be installed with a capacity of 200 kVA.

3.5 Conductor Selection on PHB-TR

Determination of PHB-TR conductor located at Pole Transformer Substation
Unknown:

$$S3\varphi = 200.000 V$$
$$V = 380 V$$
$$I_n = \frac{S}{\sqrt{3}.V} \quad (5)$$
$$I_n = \frac{200.000}{\sqrt{3}.380}$$
$$I_n = 304{,}22$$
$$I_{KHA} = 304{,}22 x 125\%$$
$$I_{KHA} = 380{,}275 A$$

From the calculation, a cable of type NYY with a cross-sectional area of 4 x 300 mm^2 is selected

Table 2. Conductor Size at PHB-TR at Transformer Pole Substation

The Unit	**Housing Blocks**	**Total Power (W)**	**Cable Size (mm^2)**	**Cable Type**
PHB.TR Pole Transformer Substation	A	50.600	300	NYFGBY
	B	50.600	300	NYFGBY
	C	48.400	300	NYFGBY

Table 3. Cable Size from PHB-TR to Group PHB in Each Housing Block

BLOCK A				
The Unit	**Number of Houses**	**Total Power (W)**	**Cable Size (mm^2)**	**Cable Type**
Main PHB	8	17.600	4 x 50	NYY
Main PHB	8	17.600	4 x 50	NYY
Main PHB	7	15.400	4 x 50	NYY
BLOCK B				
Main PHB	8	17.600	4 x 50	NYY
Main PHB	8	17.600	4 x 50	NYY
Main PHB	7	15.400	4 x 50	NYY
BLOCK C				
Main PHB	8	17.600	4 x 50	NYY
Main PHB	7	15.400	4 x 50	NYY
Main PHB	7	15.400	4 x 50	NYY

3.6 Safety Selection on PHB-TR

Determining MCCB PHB-TR at pole transformer substation
Unknown:

$$S = 200.000 V$$

$$V = 380V$$

$$I = \frac{S}{V.\sqrt{3}} \tag{6}$$

$$I = \frac{200.000}{380.\sqrt{3}}$$

$$I = 304,22A$$

MCCB Rating = $I_{nominal}$ x 125% (7)

MCCB rating = 304.55 x 1.25

MCCB rating = 380,275 A

The calculation of the MCCB rating obtained is 380.275 A, so the MCCB rating used is MCCB with a current rating of 450A - 500 A.

3.7 Determining NH Fuse PHB-TR

$I_{Nominal}$ = 304,22A

$$Arus\ Tiap\ Jalur = \frac{I_n(Ampere)}{Total\ Jalur\ Di\ PHB - TR} \tag{8}$$

$$\text{Flow of Each Lane} = \frac{304,22}{3}$$

$$\text{Flow of Each Lane} = 101,40\ A$$

KHA Fuse = Flow of Each Department x 0,9 (9)
KHA Fuse = 101,40 x 0,9
KHA Fuse = 91,26 A

The calculation obtained a KHA fuse of 96.26 A so that a NH Fuse with a rating of 100 A was selected.

3.8 Specifies PHB-TR busbar

$I_{nominal}$ = 304,22 A
I_{busbar} = 125% x $I_{nominal}$ (10)
I_{busbar} = 1,25 x 304,22 A
I_{busbar} = 380,275 A

The result of the busbar I is obtained at 304.22 A, then a 40 x 3 mm busbar is selected with a Konitnu loading of 380.275 A.

3.9 Load Safety Selection for Each Home

Safety selection for housing units

S = 2200 VA
V = 220 V

$$I_{Nominal} = \frac{S}{V} \tag{11}$$

$$I_{Nominal} = \frac{2200}{220} = 10A$$

From the calculation results obtained I nominal of 10 A. Then the MCB as a safety used for each unit of the house is rated at 10 A.

Addressing Load Development in Housing

There are several conditions after planning is carried out so that the planned electricity distribution can supply housing well for the next few years. It should also be noted that the planned development includes 68 housing units which are divided from block A to block C. This housing is planned to use a separate pole transformer substation. Based on the reference of the planning section, especially at PT PLN (Persero) Customer Service Unit (ULP) Pancur Batu, the estimated maximum power for 1 housing unit which is used as a benchmark for initial planning is 2200 VA.

Izzara Mansion Housing located in Jati Kesuma Village, Namorambe Sub-District, Deli Serdang Regency, North Sumatra is the final stage of development and it is almost certain that there will be no more additional housing units, so the transformer is planned by adding a reserve of 20% for an estimate of about 7 years ahead which aims to be able to cope with the load development that occurs in this housing or in other words as a form of anticipation if there is a load development in the housing, it is planned that electricity distribution can distribute electricity properly. With a reserve of 20%, the total transformatoryand power is selected with a power capacity of 200 kVA.

Conclusion

From the results of the research and calculations that have been carried out, several conclusions can be drawn, namely as follows:

1. Based on the data obtained, the load of each house to be installed in Izzara Mansion Housing located in Jati Kesuma Village, Namorambe District, Deli Serdang Regency, North Sumatra uses an initial power of 2200 VA for each housing unit, where the total units to be built are 68 housing unit
2. Using the analysis method in this plan, the distribution network used uses ground cables which include Medium Voltage Cable Lines (SKTM) and Low Voltage Cable

Lines (SKTR). The substation used is a pole transformer substation and the transformer to be used with a power of 200 kVA

3. Based on the results of the discussion, in this planning there has been no additional load or housing units in the area because it is the final stage of housing development, so to overcome the development of housing, namely by determining a transformer with an additional 20% which is useful for backup power as a form of anticipation in the event of load development in the housing so that the planned electricity distribution can supply electricity properly in the next few years

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