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RESEARCH ARTICLE OPEN ACCESS

DESIGN OF ELECTRICAL DISTRIBUTION SYSTEM OF PEKARZHING AREA

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Abstract:

This paper describes the designing of distribution system of Pekarzhing area for reliable power supply with ±0.95 per unit voltage profile, high efficiency, power quality, economy and security. The method involves local zoning of area, calculating its total load, computing the total numbers and size of transformer and the size of the cable. The Google Earth Pro and GIS software's are used to locate the transformer and for the underground cable laying. Aluminium cable with XLPE (Cross-Linked Polyethylene) insulator is considered in the design with certain conditions. DIgSILENT software is used to model the electrical distribution system and to conduct the load flow. Overloading of the transformer is considered. The load is calculated considering the constructions at various precincts of Pekarzhing will complete within a span of 30 years.

Keywords **—Load, Load factor, Load forecasting, Distribution System, Reliability, Ring-man system**

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I. INTRODUCTION

One of the basic needs for economic development is electrical energy. The quantity of energy services and physical environment are important for social and economic benefits [1]. Electrical energy being the source of all power system has become an essential need in life. The distribution system is an important part of the total electric supply system [2] The distribution of electricity is planned to meet the demand of consumers [3]. Consumer deserves satisfaction with power supply as they are paying for the service. The designing of a distribution system is to make conducive surrounding environment and economical in compliance with the rules and regulations. Pekarzhing is extended Phuentsholing Thromde town with an area of about 340 acres divided into six precincts; UV1, UV2, SE4, Institutional, Heritage and Parking area. Zoning has been completed by Thromde. It is supplied with 11kV Druk Cement Feeder from 66kV Malbase substation with present connected load of 4.6 MW. The town need proper electrical distribution system for reliable power supply.

Different size of pad-mounted transformers areproposed. The location of transformers and the cables are found using the GIS software and Google Earth Pro software. The model is developed in DIgSILENT software to perform load flow studies to check overloading of transformers and voltage. The paper describes

calculation of load, size and location of transformer, cable size and modelling.

II. LITERATURE REVIEW

During the load calculation, the load factor was standardized with different value for each different precinct accordingly [4]. The map and its precincts are collected from Phuentsholing Thromde which contains the suitable number of constructions of floors, percentage land use for construction and the type of future constructions in the respective precincts [5].

The primary concern of distribution planning is computing the number, locations and sizes of distribution substations [6]. Transformer size should be suitable, and its location abided by certain condition and placed carefully [5,7]. The cable size is derived from the Electrical Engineering Data book [8]. The transformers are located in GIS and Google Earth Pro [9].

The layout of distribution system follows the ring-man system to improve the voltage profile and reliability. Distribution system is a huge scope for electrical engineering as it requires the knowledge of operational inter-dependency so that a power system is successful in maintaining reliability in the system [3].

III. METHODLOGY

While designing the electrical distribution system of Pekarzhing, the following procedures are followed;

Step A: Local Zoning

The area contains seven number of precincts and then zoned into various plots. The area of each plot is calculated in auto-cad. The precincts constitutes of Urban Village Core (UV1), Medium Density Urban Village Periphery (UV – 2 (HD)), Institutional (I), Heritage Precincts (H), Service Centres and Industry (Non-polluting) (SE-4) and Parking area [5].

The UV1 constitutes of highly populated residential area where the use of machineries whose ratings less than 10 kW is prominent. Except for the night time recreational use like bar and pool rooms, other public facilities like play fields, gymnasium, swimming are allowed. The UV2 constitutes of the residential areas like resorts with a minimum plot-size of 2500m^2 and sport complex and public utility facilities with a minimum plot-size of 4000m^2 in which the equipment of higher than 10kW will be used. Institutional area constitutes of educational, training centres, public libraries, museums, and art galleries. Heritage area constitutes of culture and heritage-based area such as spiritual and religious artefacts, chortens, lhakhangs, prayer wheels, statues, monasteries and activities related to enhancement, protection and conservation of the heritage structures under the National Commission for Cultural Affairs. SE4 constitutes of service centres like ice factory and cold storage, warehouses, transport terminal for goods and passengers, restaurants, lodges, hospitality centres, bakeries and confectionaries. Parking is another extension in the zone as parking is very essential in a town development plan.

Step B: Load calculation

Firstly, the load was calculated by converting the area in square meter to square feet using the conversion formula;

1 sq.m = 10.764 sq.ft .....(1)

The area is multiplied to the percentage of land used for construction to obtain the main area. The result is multiplied to the load in kW per 1000 sq.ft of the precincts to obtain the load in kW per floor. The number of floor taken is the maximum number of the floor in each precinct [5].

After that by multiplying the number of floors and KW per floor, the sum gives the total load of the individual precincts. It is then multiplied with its respective load factor and then the load factor is classified as day load and night load [4]. Taking maximum of the day load and the night load, the total load of the area is obtained. The total load of Pekarzhing is 27.65MW.

Step C: The size and the rating transformer

The rating of the transformer is obtained by dividing the total load of the area by the power factor 0.9 [7]. The total transformer rating is found out to be 30.73MVA.

Pad mounted distribution transformers are suitable for the underground distributionsystem which are mounted on a concrete structure and fully housed with metal box for safety purposes [7].

The following table 1 shows the rating and number of transformers that are computed and required as per the design load:

Sl.no	Transformer Rating (kVA)	Numbers of Transformers required
1.	1250 kVA	22
2.	1000 kVA	1
3.	750 kVA	1
4.	500 kVA	3
5.	250 A	1

Table 1. Rating and number of pad mounted transformers

Step D: The size and rating of cable

The rating of the cable can be calculated by finding the current by

$$I = \frac{P}{VCos\varphi} \text{.....(2)}$$

Where I represent the current, P is the power in kW, V is the voltage and$cos\Phi$is the power factor. The cable size for 11 kV is selected using the data book [6].

Step E: Layout of distribution system

Geographical position, climatic conditions and the density of population are some of the factor considered for identifying the location of transformer. Geographical Information System (GIS) for geographical information and a geospatial software application called Google Earth Pro are used to locate the position of the transformers in Pekarzhing area. Some of the main conditions for locating transformers are: [7].

1. The transformer must be located as close as possible to the load center in order to reduce the voltage drop.
2. The inner location must be clear of obstructions.
3. The location must have satisfactory access for the incoming medium voltage overhead distribution line.
4. The location must be favorable for the transport of the distribution transformer to the site.
5. The transformer must be located near the road for easy maintenance.

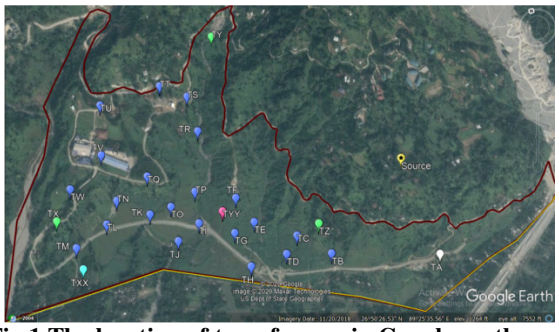

Fig.1 The location of transformer in Google earth pro.

From the load flow studies, voltage profile was found within permissible limit in case of ring-man distribution system. Hence it is proposed to increase voltage profile, reliability, and less interruption during maintenance.

Fig.2 The layout of the distribution system of Pekarzhing.

Step F: Modelling of distribution system

The modelling is done in DIgSILENT software **:**

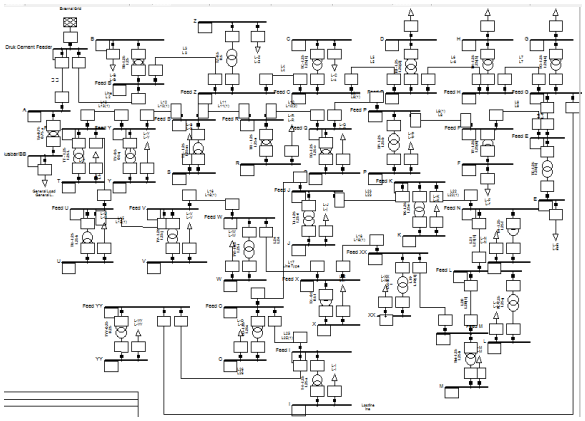

Fig 3.DIgSILENT modelling

Step G: Verifying Overloading

After performing the load flow, it was observed, alltransformers was operating to its full capacity based on the calculated load which was the maximum load of Pekarzhing, considering the scenario where all the construction is completed. The sequence of transformer installation depends on the type of construction which come up in the future as it is dependent on variables such as the availability of labour and water facility, budget, and feasibility of the land. The development pattern is forecast for the year 2020 to 2050.

IV. CONCLUSION

From this paper it is concluded that the power company can go for optimal placement of switches as the power company do not have to invest extra with the reduction of interruption cost by 10%. But this does not put constraint to other two methods. If the power company desire to improve the reliability to large scale, the use of other two methods is still feasible but with some extra investment as mentioned above. Distribution system is a huge scope for electrical engineering as it requires the knowledge of operational inter-dependency so that a power system is successful in maintaining reliability in the system. In this twenty first century, town planning is a core necessity for the livelihood survival and for a more comfortable life. The developmental act is the trunk which branches the growth of economy and the fulfilment of all necessity for lifestyle in urban areas. As an electrical engineer, one must put high prioritytowards customer demand. The distribution system must be reliable at all times, with low operation and maintenance cost to limit the tariff. The designing of the distribution system involves the calculation of load in which the area of the local zones (dividing into plots) is calculated after studying the various precincts of the Pekarzhing area carefully. The load factor considered while calculating the load which results in the day and the night load pattern. The was pad-mounted transformer of various ratings were selected. The ring-man distribution system is proposed for reliability and better voltage profile of the system.

Cross-linked Polyethylene (XLPE) is used. The exact location, number and rating of the transformers is done. The estimation of development pattern for certain period of time may not be accurate due to failure to predict the type ofupcoming construction in the near future. The distribution system planning is to meets the demand of our future generation. The methodology can be implemented to develop new ideologies and improve the scope of learning of distribution system for a reliable brighter future.

There is a scope of similar study using 33/11/0.44 kV substation and higher MVA transformer. Study can also be recommended using E-TAP software.

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