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Modelling of distribution load pattern for ODI-Olowo and Ikirun road distribution substations, Osogbo

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Abstract
Electrical energy occupies the top position in the energy hierarchy and its demand is not always met in Osogbo due to overloading of distribution transformers. In the past, several methods have been used to solve the problem of load demand and forecasting like Parametric Methods, Trend Analysis, Isolated Area Load Forecasting, Long and Short Time Load Forecasting. These methods are often inaccurate since an expensive overestimation of load demand results in substantial investment for the construction of excess power facilities, while underestimation leads to customer dissatisfaction. This work aimed to model the distribution load pattern of Odi-Olowo and Ikirun road distribution substations in Osogbo, Osun state for the purpose of forecasting load demand for the future.
Correlation coefficient of 0.661, 0.665 and 0.446 were obtained for transformer 1,2 and 3 respectively. Analysis of Variance indicated about 43.7%, 43% and 19% of the variation in capacity of transformers 1, 2 and 3 respectively.
The predicted results showed a high degree of closeness for the distribution load pattern of the three transformers.The model developed can be used to determine the load pattern of electrical distribution substation which will assist utility companies in efficient operation planning.

Keywords: Distribution, load pattern, modelling, road distribution, substations

1. Introduction

1.1 Background of the Study

The power electricity synchronous machines have the features of starting control mechanism in order to execute its operation. For example, an induction motor can be triggered or halted making the switch on or off and its speed can be conveniently controlled over wide range with simple arrangements.

The historical and the present- day development of mankind are interlinked with energy, and this will be helpful in the generation of electrical energy. Hence, this occupies the highest hierarchy in electrical system. This gives rooms for significant uses in domestics, industrial, farming and transportation. Besides its use in homes, industrial and commercial purposes it is required for increasing defense and agricultural production. In agriculture, this is useful for irrigation water supply and improving the methods of production and numerous other operations.

At present about three- fourth of the accumulation of energy still used, is in non- electrical form but because of numerous advantages, electricity will account for a greater allocation of the cumulative consumption in the shortcomings. It is expected that the electricity demand will continue to go up for many years to come in a well developed countries [2].

Precise and reliable forecasting will lead to economical savings during operation and reduce maintenance costs. This will lead to improvement on the reliability of power supply and delivery system. Power load demand is accessible during periodic consumption and accumulation of the hourly, daily, weekly, monthly and yearly periods [1-2].

1.2 Statement of the Problem

Electricity is in high demand across the globe and Osogbo cannot be exempted. Average scale enterprises need electrical energy at night and during the day, domestic consumers use the same for cooking, lighting and recreation.

The demand for electricity supply was not met by the consumers due to some factors, one of such is the overloading of the distributions transformers, whenever the maximum rating of the substation transformer is exceeded, there would be interruption in supply. To curb this, a model for distribution load pattern is proposed for Odi-Olowo and Ikirun road distribution substations which will forecast load demand in the future.

1.3 Aim and Objectives

Aim

The aim of this research is to develop a model for the distribution load demands pattern of Odi-Olowo and Ikirun road substations within Osogbo metropolis, Osun State with the goal of forecasting load demand in the future.

Objectives

The objectives are to

1. Collect peak loads from the hourly readings of the two distribution substations
2. Perform regression analysis on the collected peak loads.
3. develop a mathematical model to describe the load pattern, and
4. Use the load pattern to forecasting future load demand.

1.4 Justification of the Study

The implementation and economic viability of a power system depend greatly on the accuracy of the short and the long term period forecasting of the electrical load demand. This work is expected to generate results that will help supply authority meet the ever increasing load demand of both domestic and industrial consumers want uninterrupted power supply.

1.5 Scope of the Study

This study focuses on power overloading in GRA, Ilesa road, OSBC, Gbongan road, Obelawo area, Oluode area, Igbona and National Control Center, Osogbo.

2. Literature Review

2.1 Substations

For electric generation, transmission and distribution networks, substations are important components. Essentially, substations convert high to low voltage and low to high voltage. Furthermore, substations reduce the power consumption from generating stations. Electrical power can also be transferred between the generating plant and consumers by various substations, and the voltage can be adjusted in several steps [3].

2.1.1 Distribution Substation

A substation moves power to an area's distribution system from the transmission system. Unless they use huge power supplies the distribution station lowers voltage to a level appropriate for a regional decentralized supply [4] it is far from feasible to connect energy users to the primary transmission network immediately.

In many areas, unnecessary voltage switchings and low voltage backup systems are complicated substations. Less frequent supply substations are fitted with a switch, transformer and low-voltage centers. Transportation power from substations to the premises of the user [3-4]. Switch electricity from substations.

2.1.1.1 The Components of a Distribution Substation

Fig 1: Voltage Transformers (Courtesy of trendy electric powered, Distribution systems, Substations, and Integration of Disbursed Generation [4]

Fig 2: Diagram of An Outdoor Switch-Gear Busbar (Courtesy of General electric powered, Distribution systems, Substations, and Integration of disbursed era. [4-6]

Fig 3(a): Switchgear (a) Switchgear Control Panel [5]

Fig 3(b): (b) Hybrid Switchgear [5-6]

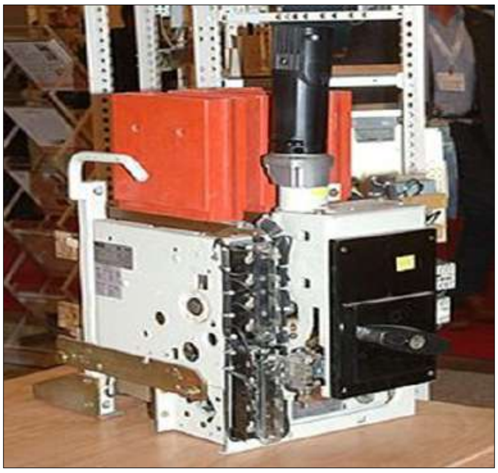

Fig 4: Circuit Breaker source [7-8]:

3. Methodology

3.1 Data Collection

The IBEDC transformer readings were taken from January 2009 to December 2015. Peak hourly readings were extracted from the hourly reading sheets of the IBEDC. The transformers were labeled T_1, T_2, and T_3 respectively as seen in Figures 5 and 6 respectively. T_1 and T_2 are at Odi – Olowo distribution station while T_3 is at Ikirun road Distribution station respectively.

3.2 Statistical Tools

3.2.1 Data Editing

The relevant data obtained in each solution were recorded, sorted, summarized and arranged on daily basis.

3.2.2 Data Transformation

The data collected on daily basis for the study were transformed. Microsoft Excel package was used for data transformation. The formula for the transformation is:

$$P = \frac{\sqrt{3}(1100\,\text{A})}{10^6} \tag{3.1}$$

Where A is the actual reading in Amps and P is total power in MVA

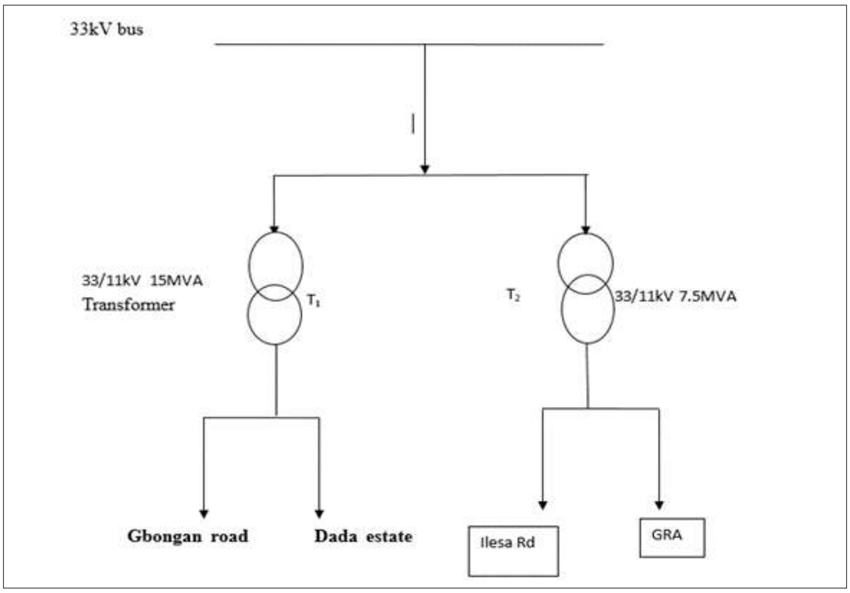

Fig 5: Osogbo Township Odi-Olowo Distribution Substation Network

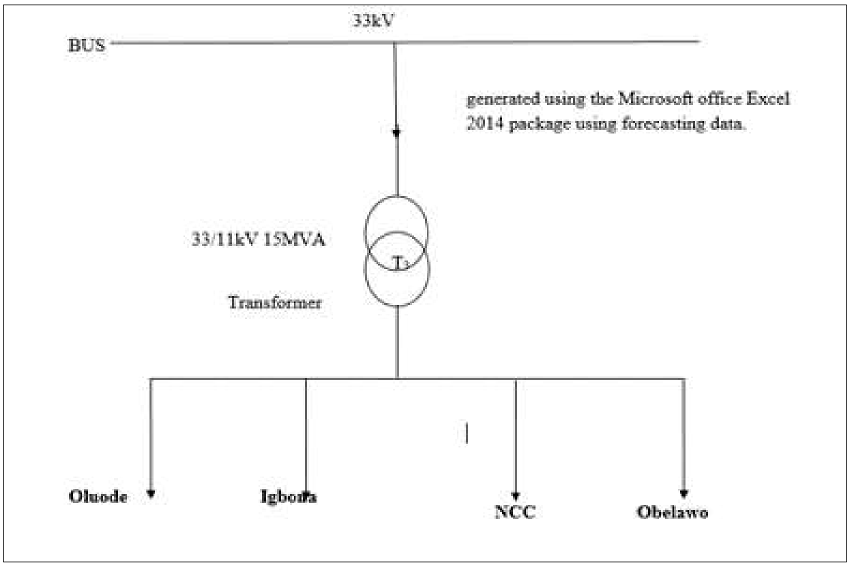

Fig 6: Osogbo Township (Ikirun road) Power Line Distribution Substation Network

4. Results and Discussion

4.1 Scattered Plots

To determine the linearity of the developed statistical data, a scattered plot which was illustrated in Figure 7 This graph illustrate the linear correlation between the load of the transformer and date. This plot was generated using the Microsoft office Excel 2014 package using forecasting data.

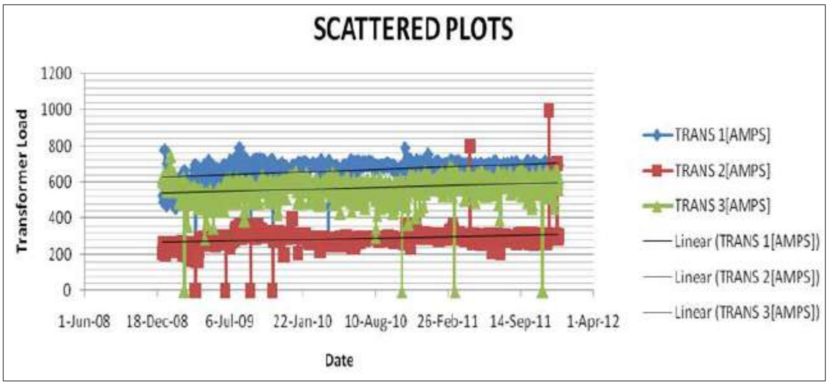

Fig 7: Scattered Plot Illustrating the Correlation between the Transformer Loads and Date

5. Conclusion and Recommendations

5.1 Conclusion

The drive for this work is simply the problem of high electricity demand that resulted in overloading of distribution transformers in Osogbo and its environs. Consequently, this work was set out with the goal of modeling the distribution of load demand pattern in Odi-Olowo and Ikirun substations within Osogbo, Osun State by forecasting load demand in the future. In attempts to meet the objectives of this work, peak loads from the hourly readings (between January 2009 and December 2013) of the two distribution substations were collected from IBEDC. The transformers were labeled T_1 and T_2 for Odi - Olowo distribution station while T_3 is for Ikirun road distribution station. The data collected were analyzed and prepared using the SPSS (Statistical Packages for Social Science). Statistical analysis of linear regression, variance (ANOVA), and correlation were used.

Resulting from the analysis of the data, the modelling of the equations were evaluated for the transformers using least square method, a test of significance was derived and experimented for best line of fit or surface. The end result of the regression evaluation confirmed that there has been a linear relationship between the transformers load demand and dates as indicated by scattered plot generated. The regressional value suggests a strong positive linear relationship between date and co ad. The final output of linear correlation based on Pearson correlation gave a correlation coefficient of 0.66 between transformer and date, 0.665 between transformer 2 and date and 0.446 between transformer 3 and date. The result of Analyses of variance (ANOVA) indicates about 43.7%, 43% and 19% variation of load data in T1, T2 and T3 respectively.

5.2 Recommendations

Arising from the success recorded in this work, it is suggested that the following should be addressed for further development:

1. There should be a link between research work of this nature and the utility company to enhance better performance.
2. The data range should be extended to further show the efficiency of the maximum load demand.

The mathematical model should be tested under wide coverage area with the goal of achieving general result.

5.3 Acknowledgements

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