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

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Abstract

At the very top of the energy ladder is electrical energy, and Osogbo's need for it isn't always satisfied since distribution transformers are overloaded. Many approaches have been used in the past to address the issue of load demand and forecasting, including as trend analysis, isolated area load forecasting, long and short time load forecasting, and parametric techniques. Because of the high costs associated with building surplus power facilities due to an overestimation of load demand and the high costs associated with customer displeasure due to an underestimating, these approaches are generally incorrect. In order to predict future load demand, this effort sought to simulate the distribution load pattern of the substations on Odi-Olowo and Ikirun roads in Osogbo, Osun state.

For transformers 1, 2, and 3, the corresponding correlation coefficients were 0.661, 0.665, and 0.446. The analysis of variance revealed that transformers 1, 2, and 3 accounted for about 43.7%, 43%, and 19% of the difference in capacity, respectively.

The distribution load pattern of the three transformers was quite similar to the projected results.Utilities may utilise the created model to better plan their operations by identifying the electrical distribution substation's load pattern.

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

1. Introduction

2. In order to function, power-electric synchronous machines need a beginning control mechanism. Take an induction motor as an example. Its speed can be easily adjusted across a large range with simple setups, and it can be triggered or stopped by simply turning the switch on or off. Because of the interconnected nature of energy with human history and contemporary progress, this will aid in the production of electrical energy. To that end, it stands atop the electrical system's food chain. This opens up a lot of possibilities for transportation, agriculture, residential, and industrial usage. It is essential for improving agricultural and military output in addition to its domestic, industrial, and commercial uses. Irrigation water supplies, production techniques, and a plethora of other agricultural activities may all benefit from this. Electricity will make up a larger portion of the overall consumption in the future due to its many benefits, however now over three quarters of the energy is being consumed in non-electrical forms. Power consumption in industrialised nations is predicted to rise for the foreseeable future [2].

You may save money on operations and maintenance with accurate and dependable forecasts. As a result, the power supply and distribution system will become more reliable. Consumption and buildup of power load demand on hourly, daily, weekly, monthly, and annual intervals are observable [1-2].

2.1 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.

2.2 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.

2.3 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.

The Components of a Distribution Substation

2.4 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.

3. Literature Review

3.1 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].

3.1.1 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.

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]

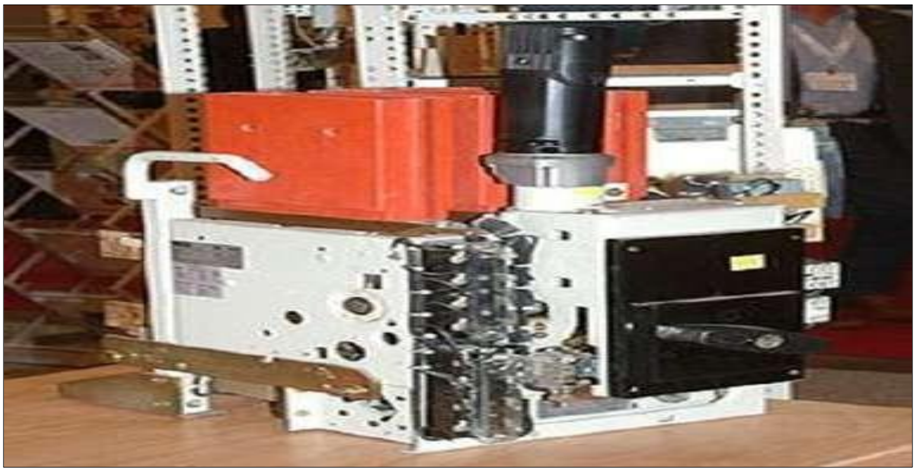
Fig 3(b): (b) Hybrid Switchgear [5-6]

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.

Statistical Tools

Data Editing

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



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:

4. Methodology

4.1 Data Collection

$$P = \sqrt{3}(1100\,A)$$

The IBEDC transformer readings were taken from January 2009 to December 2015. Peak hourly readings were Where A is the actual reading in Amps and P is total power in MVA

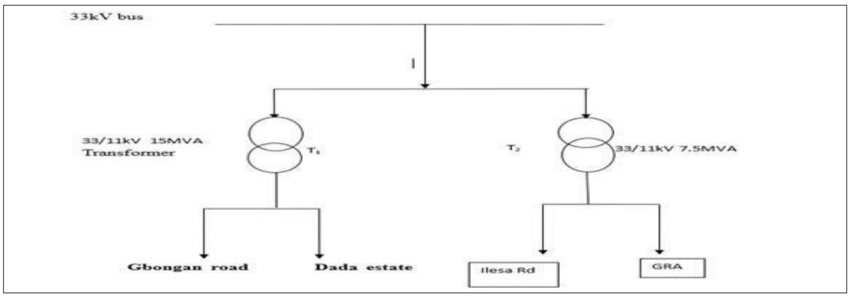


Fig 5: Osogbo Township Odi-Olowo Distribution Substation Network

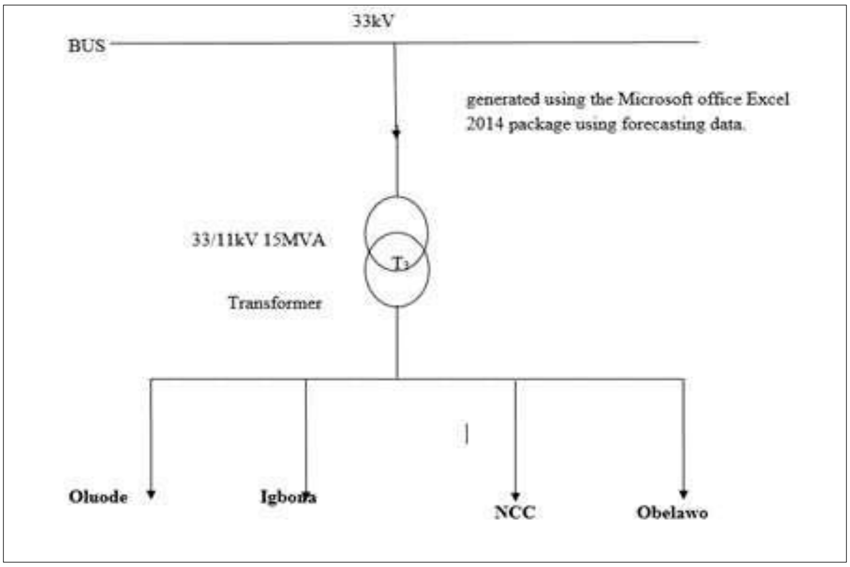


Fig 6: Osogbo Township (Ikirun road) Power Line Distribution Substation Network

5. Results and Discussion

5.1 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.

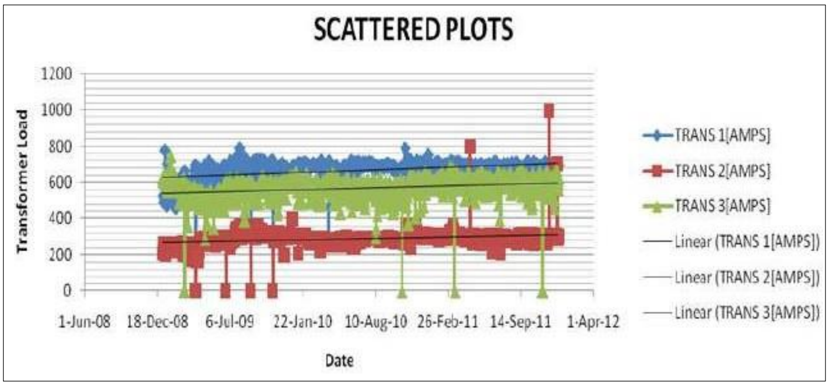


Fig 7: Scattered Plot Illustrating the Correlation between the Transformer Loads and Date

6. Conclusion and Recommendations

6.1 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.

6.2 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.
3. The mathematical model should be tested under wide coverage area with the goal of achieving general result.

6.3 Acknowledgements

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7. References

8. 1. In the 2015 issue of Alexandria Engineering journal, pages 137–144, Almeshaiei and Soltan presented a model for electric power electrical load forecasting.
2. In 2018 McGraw Hill published the 11th edition of the Standard Handbook for Electrical Engineers, written by Donald G., Fink H., and Wayne B.
3. Huang CC, Ho KL, Lai TS, Lee TE, Hsu YY, Chen FF, Liang CC, and others. IEE proceedings-generation, Transmission and Distribution, vol. 140, 2017;1:17-29, short-term load forecasting of the Taiwan power system.

Four, Lourenco and Santos. Models for the Gaussian system for short-term load forecasting purpose. Volume 52, Issue 58, 2014, Institute of Systems Engineering and Computers, Combria, Portugal.
The international journal of science and engineering published an article by Messalti, Zitouni, and Griche in 2013 titled "layout of Mv/Lv Substation Transformer" (pp. 20-25).
6. Quintana VH, Temraz HK, Hipel W. IEE Proceedings generation, Transmission and Distribution 2018;140(1):17-29. A two-stage power-gadget-distribution planning algorithm.
7. The application of generalised long memory is required for forecasting power (Soares LJ, Souza LR). Predictions 2016;22(1):17-28. International journal of forecasting.
9. Yeh EC, Tram H., "Information integration in automatic distribution machine making plans," IEEE Transactions on power systems, 2017;12(2): 1008-1013.