IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, July 2023

Energy Efficiency Improvement to Reduce Losses in the Electric Power Distribution System

Ugendran K[1] and Dr. Prabodh Khamparia[2]
M. Tech Student, Department of Electrical Engineering [1]
Professor, Department of Electrical Engineering [2]
Sri Satya Sai University of Technology and Medical Sciences, Sehore, India

Abstract: *The distribution network of the Pune zone, which consists of the four 11kV distribution feeders A, B, C, and D, was analysed in this research. A and B Street distribution networks were taken into account in this study to increase electricity quality. The 165 MVA transmission station, located at the XYZ intersection, supplies the three (3) 33/11kv injection substations. The first thing that was taken into account was the gathering and analysis of data from the injection substations that feed energy to Moshi and Bhosari. Using Newton-Raphson Load Flow equations, the distribution network was modeled in the Electrical Transient Analyser Program (ETAP). The network's modeling of its current state reveals that it has a low voltage profile issue on the B network and overloading of distribution transformers on the A network.*

Keywords: Pune Zone, Transmission Station, Newton-Raphson Load Flow, Feed Energy

I. INTRODUCTION

Transformers, feeders lines, injection, and substation overload are the results of increasing load, incorrect transformer sizing, unilateral network extension, and a decrease in the amount of power available, all of which lead to inefficient energy dispatch to meet the rising load demands of the consumers [1]. As a result, customers who are linked to the impacted substations often face under-voltage, epileptic power supply, and blackouts. Many households and commercial organisations must undoubtedly operate their own independent power generators to supplement their power needs because the majority of distribution lines are too large in size, especially the secondary distribution networks [4]. Power distribution companies then turn to unplanned load-shedding and power rationing as a backup source of energy in an effort to lessen these difficulties. However, a system upgrade is necessary to fulfil the distribution system's constantly increasing load demand. This may be done by performing a power flow analysis on the current network to identify the different degrees of its insufficiency. As a consequence of the distribution networks' setback, substations are not receiving enough power relative to the net power provided to the load. Thus, using network reconfiguration techniques makes it possible to improve the network instability under investigation in order to achieve better performance with the goal of improving the voltage profile of the distribution network within the acceptable limit to reduce network losses, while reducing transformer working stress, and thereby providing proper accessibility of the power supply to the consumers at the receiving end [5].

In order to ensure and minimise loss reduction levels for effective power quality and enhance voltage profile, this research focused on how to optimise energy-saving efficiency approach for electric power losses in the distribution network.

II. LITERATURE SURVEY

In order to enhance power quality and provide a steady supply of electricity, distribution networks are a crucial and fundamental part of power system evaluation. Since the daily increase in power supply is not keeping up with the necessary energy demand at consumer ends. The high level of influx of newcomers into Bhosari, a city that is rapidly expanding, raises the daily energy requirements of both residential and commercial customers. Although earlier studies on the distribution of electric power in other cities have been conducted ([1]; [8]; [2]; [9]), it was felt that not enough research had been done to determine how to optimize energy efficiency for losses in the Moshi, Bhosari distribution network, which consists of four (4) 11kV distribution feeders named A, B, C, and D.

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, July 2023

The 165 MVA transmission station will provide energy to the distribution network's B and A injection substation for a period of three years and then beyond. The simulation will make use of the ETAP programme and the Newton-Raphson load flow analysis approach (Asha et al., 2014). Since reliability is a measure of the probability of performance from the sending to the receiving and power supply, this research clearly demonstrated the need for reliable assessment of electric power delivery to the consumer with respect to consideration of energy losses on a continuous basis, particularly to the study case under investigation, and on the new to propose a power electronic controller (Facts-device), with particularly 0.3 MVAR capacitor ban.

III. MATERIAL AND METHODOLOGY

In this study the materials utilized were line parameters of network 11KV distribution, transformer rating/capacity, bus bar, single diagram (SLD) were modeled in electrical analyzer. Similarly, the methodology considered was the application of Newton-Raphson load flow, embedded in E tap tools, with voltage drop equation technique which include the rates of the basic load configuration:

- A concentrated load is the simplest arrangement
- Equal loads disbursed evenly on a line may be replaced by a single total load.
- Non-equal loads unevenly disbursed require analysis by nodes and sections.

The real world most feeders required many calculations. The simplified system configuration is presented as in equation 1:

$$R = \frac{kW}{kV_{LL} \times \sqrt{3}} \quad \textbf{Eq.1}$$

I - Current in amperes

KV_{LL} - Line to line voltage at the load (kilo volts or 1000's of volts)

KV Source - Voltage Drop (l000's of volts)

KW - Three Phase Load (kilowatts or 1000's of watts)

Volts Drop = I (R Cos Ø + X Sin Ø) Eq.2

I - Current (Amps)

R - Resistance (ohms)

X - Reactance (ohms)

Cos Ø -Power Factor of Load

Voltage drop is for one conductor (line to neutral).

IV. RESULTS AND DISCUSSION

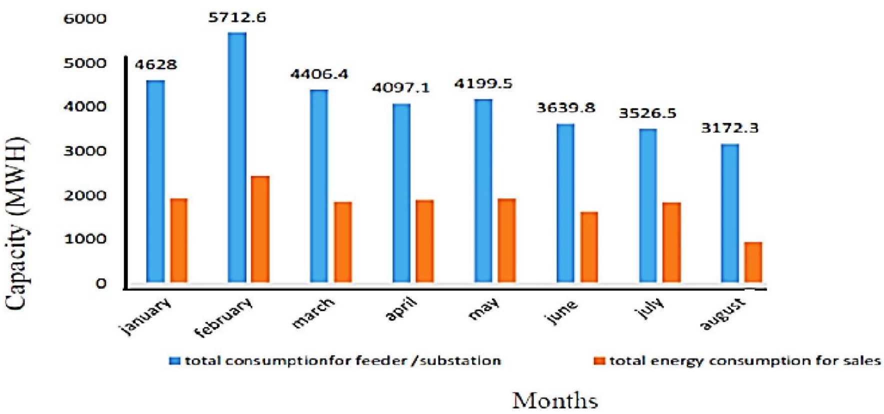

Figure 1: Total Energy Delivered (MWH) to the Feeders/Substation-2020

The figure 1 shows the total energy delivered for consumption as compared to the energy delivered for sales in 2020. The electric utility suffered losses over the period of January – December, 2020, this means that PHEDC and the

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, July 2023

utilities need to install digital meter monitoring and capturing device to actually determine the customers who is actually consuming and not paying for electricity bills.

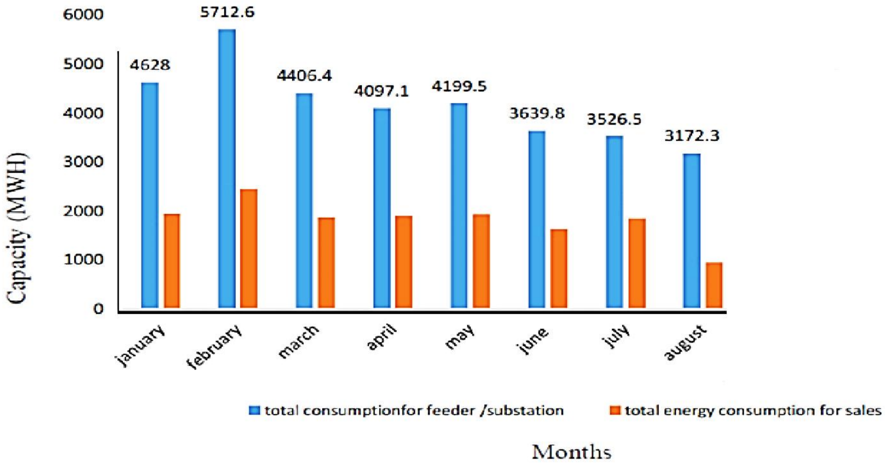

Figure 2: Total Energy Delivered Feeders/Substation-2021

The figure 2 shows the distribution of total energy delivered for consumption 2021 versus energy delivered for sales with associated monthly losses (MWH) this means that PHEDC and the utilities need to install digital meter monitoring and capturing device toactuallydeterminethecustomerswhoisactuallyconsumingandnotpayingforelectricitybills.

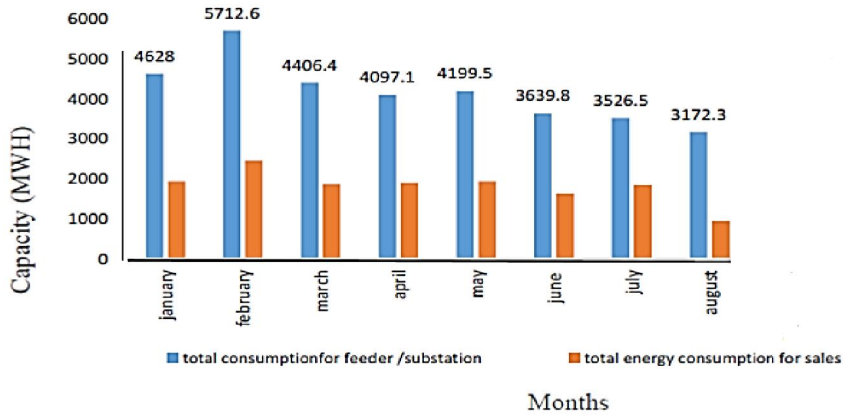

Figure 3: Total Energy Delivered Feeders/Substation-2022

The figure 3 shows the composite bar-chart distribution of total energy delivered for consumption – 2022 as compared to energy delivered for sales. That is energy actively delivered to the feeder/station does not match energy sales for consumption as a resultsoftechnicallosses,overloadandnon-installationofprepaidmetercapturing(payas youuse).

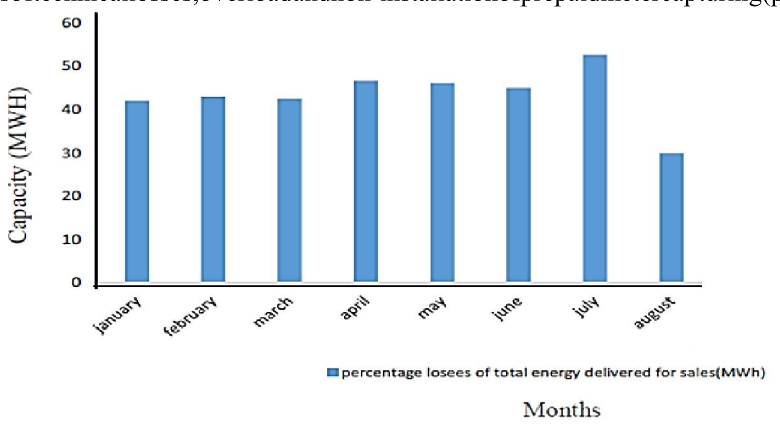

Figure 4: %Monthly Losses Energy Delivered to the Feeder/Substation-2021

IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.301
Volume 3, Issue 1, July 2023

The figure 4 shows the distribution of percentage losses of total energy delivered for sales (MWH) as compared to the monthly activities in 2020. The loss of energy during technical or non-technical losses can be minimized with the integration of digital meter in order to make a savings.

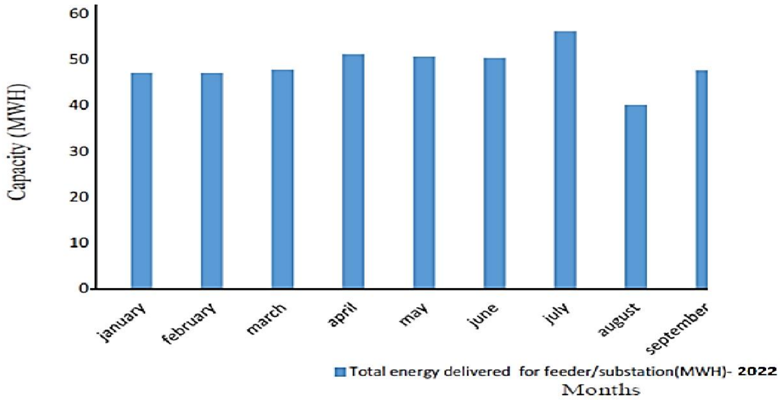

Figure 5: Percentage Monthly Losses Energy Delivered to the Feeder/Substation -2022

The figure 5 shows the energy profile distribution of total energy delivered for feeder/substation (MWH) for monthly activities under study. The energy delivered ideally need to match the needed energy demand but due to losses, the profit (saving) return on investment is poor as compared to expected on energy sales.

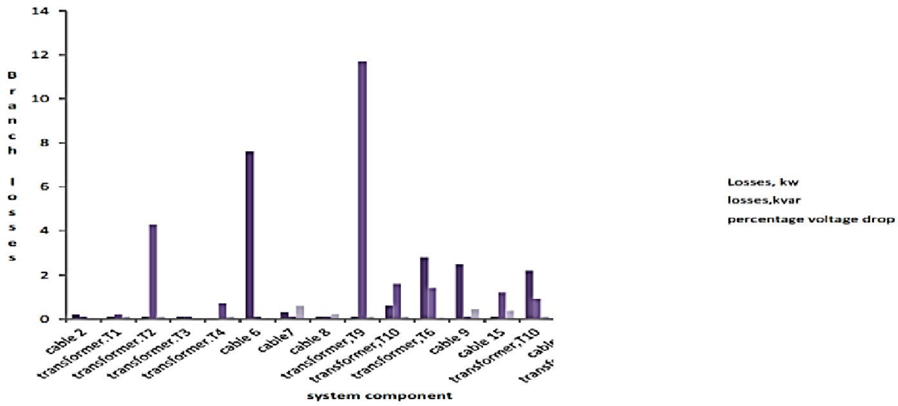

Figure 6a: Without Capacitor Bank Placement in the Network

The figure 6a branch system losses in KW, KVAR and percentage voltage with the distribution of system component as cables, transformer etc. The branch losses due to power (KW, KVAR etc.) need to be compensated in order to improve power quality and reliable electricity supply in order to encourage and promote economic activities.

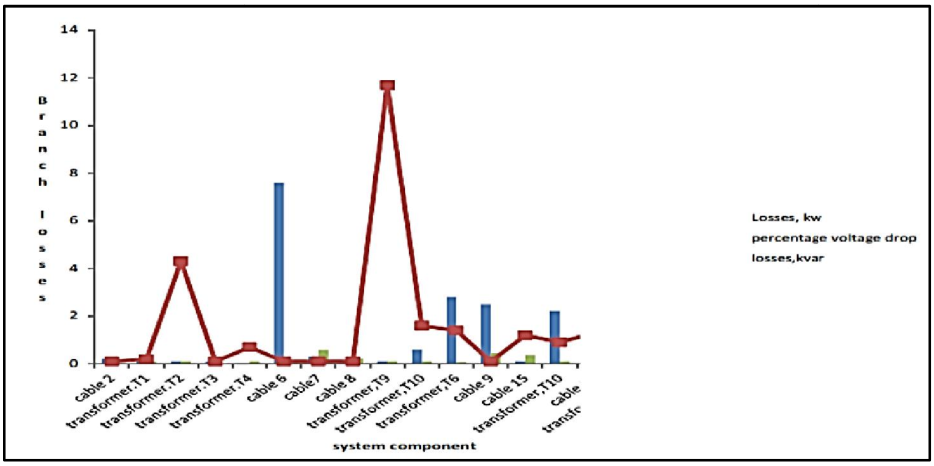

Figure 6b: System Component Losses Percentage Voltage, Drop, Losses KVAR

IJARSCT

ISSN (Online) 2581-9429

International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)

International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal

Impact Factor: 7.301

Volume 3, Issue 1, July 2023

The figure 6b shows the branch losses and system component with respect. The losses due to power system component a cable, transformer .Composite representation of line of bar chart showing the losses due to overload on the already congestion network. proposed for improved power factor and quality.

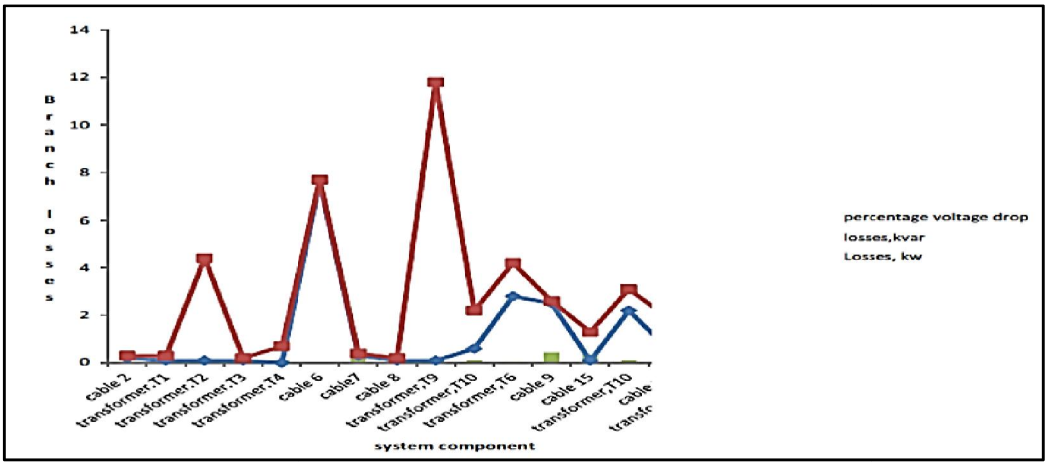

Figure 6c: System Component Losses kw, Percentage Voltage, Drop, Losses KVAR

The figure 6c shows the distribution of branch losses and system. The losses were measured in KVAR, KW, etc. The branch losses are presented versus system component to observed the distribution of consumption of energy, on the view to proposed upgrade of the existing system states.

V. CONCLUSION

The current Moshi, Bhosari distribution network, which comprises of four (4) 11kV distribution feeders named A, B, C, and D, was studied as part of the research. From the 165 MVA transmission station at the XYZ intersection, their respective 33/11kv injection substations are supplied. Using the Gauss-Seidel power flow equation, the distribution network was modelled in the Electrical Transient Analyzer Programme (E1AP). Both the changed (post-upgrade) network and the pre-existing, pre-upgrade network underwent power flow study.

Under voltage buses, overloaded transformers, feeders, and substations were detected when the findings were analysed. Transformer loading exceeding 70% is considered overloading while voltage levels below 95% are considered to be under voltages. In the post-upgrade, the causes of the under voltage and overloading were determined, and cost-effective optimisation solutions were suggested. Based on the results, it can be said that power flow studies are crucial for defining the ideal operating conditions for both the present system and future plans for power system growth. It was discovered that feeder bifurcation, transformer load tap changers, and distribution transformer upgrades were beneficial in enhancing the voltage profile of the weak buses, cutting losses, and removing overloading from the system

REFERENCES

[1] Adegboye B. A. (2010) Analysis of Feeders Outages on the Distribution System of Zaria Town. Faculty of Engineering, University of Maiduguri, Nigeria. Arid Zone Journal of Engineering, Technology and Environment. 7, 1-13.

[2] Ale, T. O., & Odesola, A. O. (2015). Unreliable Electric Power Supply in Nigeria (Akure 11kV Feeders a Case Study). International Journal of Emerging Engineering Research and Technology, 3(3), 68-75.

[3] Asha, N., Tamizharasi, P. & Deepalashmi, U. (2014) Energy Saving Using Bifurcation of Distribution Transformer Department of Electrical and Electronic Engineering Adhiparasakthi engineering College Tamilnadu, India International Journal of Innovation Research in Advanced Engineering, volume 1.

[4] Behailu, A. (2014) Designing of an Improved Distribution Substation to Mitigate the Power Reliability of Bishoftu City Defence University, College of Engineering, Department of Electrical Power Engineering, Ethiopia.

[5] Chen X. & Liu L. (2012). Distribution Network Configuration Based on Niche Binary Particle Swarm Optimization Algorithm. Department of Electrical Engineering, Shenyang Institute of Engineering, Shenyang, China. International Conference on Future Electrical Power and Energy System.

[6] Elkadeem, M. R., Alaam, M. A., & Ahmed M. A., (2016). Improving Performance of Underground MV Distribution Networks Using Distribution Automation System: A Case Study. Am Shams Engineering Journal.

[7] Hassan N., Kingsley M. U., &Chinedu P. E., (2017). Optimal Location of Facts Device for Improved Power Transfer Capability and System Stability. International Journal of Energy and Power Engineering, 6(3), 22-27.

[8] Kehinde, O., Ayodele, S. O., Temitope, A., &Adedayo, K. B. (2014). A Fault Analysis of 11kv Distribution System (a Case Study of Ado Ekiti Electrical Power Distribution District). American Journal of Electrical Power and Energy Systems, 3(2), 27-36.

[9] Jibril, Y., &Ekundayo, K. R. (2013). Reliability Assessment of 33kV Kaduna Electricity Distribution Feeders, Northern Region, Nigeria. Proceedings of the World Congress on Engineering and Computer Science, 1.