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Enhancement of transmission line parameters for the supply of energy in the Rivers state local government area of Obio Akpor

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Abstract

Efficient energy transmission is crucial for meeting the growing demand for electricity, particularly in urban and rural areas. In the Rivers State Local Government Area of Obio Akpor, Nigeria, ensuring reliable power supply is essential for supporting economic development and improving quality of life. However, challenges such as transmission line losses, voltage fluctuations, and inadequate infrastructure hinder the effective distribution of energy in the region. This article presents a comprehensive study on enhancing transmission line parameters to improve energy supply in Obio Akpor. Through field measurements, data analysis, and simulation studies, the performance of existing transmission lines is evaluated, and strategies for enhancing efficiency and reliability are proposed. The literature review explores previous research on transmission line optimization, emphasizing factors such as conductor material, line design, and insulation to minimize losses and maximize power transfer capability. Materials and methods encompass data collection, including impedance measurements, voltage profiles, and load characteristics, followed by computer simulations to assess proposed enhancements.

Keywords: Efficiency; Reliability; Optimization; Infrastructure; Nigeria; Transmission lines; Energy supply; Obio Akpor.

1. Introduction

The request for electrical control continuously surpasses the supply particularly within the creating nations like Nigeria, coming about to undesirable control sharing in this manner causing inefficient control supply framework. By and large, in Nigeria, variables contributing to wasteful and untrustworthy control supply separated from moo control era may incorporate destitute or incapable voltage control framework, destitute transmission systems, exceedingly over-burden transmission feeders due to need of arranging, defective dispersion framework on the portion of the electrical providers, voltage drop along the line and from the conveyance framework due to the stream of current and stack varieties on the customer conclusion, harm to substation, transmission and conveyance organize, brief circuit or over-burdening of electrical mains, and stumbling of control framework. Overhead transmission lines are the most components of the control framework. Different progressed calculations of the control framework, such as lattice modeling, state estimation, control stream calculation, and transfer assurance settings, require precise transmission line parameters Bendjabeur et al., 2019.

In the calculation of the real transmission line parameters, most of the control framework administrators utilize electrical gear to misleadingly apply a certain voltage after the transmission line is raised and not put into operation, and calculate the double ended electrical parameters of the line through exactness measuring rebellious Xiao et al., 2016. Be that as it may, when the transmission line is energized and worked, influenced by the working conditions of the transmission organize, line environment, regular changes and other components, there are certain contrasts

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between the genuine line parameters and the parameter values initially calculated Asprou et al., 2018 Yu et al., 2018. The transmission line parameter mistake will genuinely reduce the calculation precision of the state estimation within the nearby lattice region, at that point influence the exactness of the calculation comes about of different progressed applications based on the state estimation, truly meddled with the investigation and control of the control framework by dispatchers Liu et al., 2020. The transmission line has basically four parameters; resistance, inductance, capacitance and shunt conductance. These parameters are consistently conveyed along the line, additionally called the disseminated parameter of the transmission line.

Therefore, examining the exactness and energetic alteration of transmission line parameters has critical hypothetical and down to earth centrality. For a long time, in arrange to progress the exactness of transmission line parameters, residential and remote specialists have carried out numerous related inquires about on transmission line parameter estimation and parameter optimization, which can be separated into two primary categories 1 Based on control lattice state estimation, grow calculations from diverse points, such as increased state estimation strategy Xue et al., 2014, ordinary condition estimation strategy Tang et al., 2018, Kalman channel estimation strategy Wang et al., 2019c and remaining affectability examination strategy Su et al., 2019. Among them, the writing Wang et al., 2019a Kong et al., 2020 proposed a strategy to produce suspicious lines by calculating estimation deviation and line adjust state, and utilized variable step integration strategy to appraise the parameter adjustment esteem of suspicious lines. Writing Xue et al., 2019 proposed a comprehensive strategy based on PQ decoupling combined with expanded state estimation and sensitivity methods to realize line parameter mistake redress. Writing Viafora et al., 2019 proposes a two-step state estimation calculation that takes under consideration line temperature. In any case, these strategies for the most part confront the issue of ill conditioned coefficient framework. In specific, a expansive range of line parameters can be expanded to state values to attain the arrangement of parameter values, which comes about in as well high matrix measurements, genuinely influenced state estimation comes about, and the calculated parameter values cannot meet the fundamental precision prerequisites of different progressed applications of control network vitality administration system. 2 Based on the measured esteem of the transmission line segment, the parameter optimization based on manufactured insights calculation incorporates molecule swarm optimization strategy Qu et al., 2018 Zhu et al., 2020, hereditary calculation Shi et al., 2009 Li et al., 2020 and Tabu look strategy Dai, 2020. Among them, Huang et al., 2019 proposed a strategy for assessing line parameters of dissemination organized based on outspread premise work neural arrange, which can get exact line parameters by utilizing the measured values at both closes of the line. In writing Ren et al., 2019 Dutta et al., 2020, multi time SCADA and PMU estimations of a single line are individually utilized for parameter estimation. Recreation comes about and can viably gauge the impedance parameters of the line. Writing Ghiasi et al., 2019 prepared and learned an expansive number of multi section dynamic control information, the sparsity of the line parameter contrast and the practical tether calculation are utilized to redress and illuminate the suspicious line. This sort of strategy has gotten to be the standard investigate thought, which gives vital reference and hypothetical direction for ensuing inquire about. Based on the over inquire about different optimization strategies, the current transmission line parameter estimation or optimization method has two deficiencies within the arrangement calculation The effective influence of the line operation mode on the parameters isn't considered and calculated, coming about within the need of exactness of parameter values. and the calculation of transmission line parameters within the revised scheme cannot be combined with the state information of the most recent line operation mode. As it were verifiable information is utilized to calculate line parameter values, and the produced parameter values are not real time, and it isn't suitable to be connected to progressed real time calculations of different control frameworks.

Transmission line parameters such as resistance (R), reactance (X) and susceptance (B) are the prerequisites for cutting edge control framework operation, control and arranging investigate Salam, 2020. In this work, by analyzing the inner and outside variables that meddled with the line parameters amid the operation of the transmission line, the pertinent affecting components reflecting the working conditions of the line and the normal natural parameters are at first decided, and the degree of impact is measured. At that point, a strong influence include determination demonstrate based on the imperative of the impact coefficient is built to break the impediment of the particular input amount of the conventional electrical calculation demonstrate. More comprehensiveline parameter impact characteristics are considered as parameter optimization contemplations.

Frequent power outages arising from destitute state of power foundation is ruining Nigeria s socio economic development. Obio Akpor is one of the foremost cities in Stream state here trade and social exercises are getting to be quickly more subordinate on power. Any control blackout, indeed of the most brief length, in Obio Akpor has severe socio economic impacts and there's no probability that the wonder would abate indeed within the closest future. In Obio Akpor, It was found that lacking control producing capacity, deficiency of gas, powerless and broken down electrical transmission and dissemination organize, insufficient control framework offices, etc. are the chief causes of unremitting control outages. These inadequacies over the a long time have brought about to untrustworthy and spurious voltage varieties and visit control blackouts. An Effective and progressed control supply framework is one that looks for to

overcome the over deficiencies and conveyed superior quality of control to neighborhood customers and mechanical clients. It is in this way in this light that the analyst wishes to create a demonstrate for the Advancement of transmission line parameters for power accessibility in Obio Akpor neighborhood government Region of Rivers state.

2. Materials and method

2.1. Obio Akpor Electrical System Layout Materials

For the purpose of analyzing and looking at this base case, the Port Harcourt Electricity Distribution Company (PHEDC) will be the source of the distribution data. This study case's analytical methodology is explained in accordance with the relevant problem formulation scenario.

2.2. Materials Requires

- Electrical Transient Analyzer Programme (ETAP 12.6.0) simulation software
- Cross section area of conductor is 182mm^2
- ACSR/Gz. (Aluminum conductor steal reinforced)
- Distribution Transformation Voltage rating (330/33KV,132/33kv, 33/0.415kv)
- Network Structure (acquire network redraw with (ETAP)
- Static var compensator(SVC)

2.3. Technique used for Improving the transmission line Network

Although there are many methods for enhancing the voltage profile and lowering network losses in transmission line networks, the following methods will be taken into consideration for this research.

- Conductor grading (resizing)
- High voltage distribution system
- Optimal capacitor placement (OCP) for voltage profile improvement

2.4. Network (feeder) reconfiguration

The power conveyance Arrange in Obio Akpor nearby government zone has experienced colossal changes from the initial plans of the organize, as seen in other portion of the state, circumstance where communities proceed to develop the existing organize with or without the notice of the utility suppliers from the point of unique development. That by the by, it has its claim inadequacies due to a number of variables, chief among them is hardware maturing extending from feeder lines, switchgears, dissemination lines, transformers, feeder columns etc. The distribution voltage levels is 33KV a really high voltage that required tolerability in development since could be a organize found in a rustic region the benefit suppliers are not continuously on ground to handle a few basic issue in direness. Obio Akpor nearby government zone power conveyance is tapped from Woji 33 11KV infusion substation which supplies control to the area and it implies an blackout on this specific feeder will cause a add up to blackout to the complete Obio Akpor, adding to the less than normal control gotten within the Obio Akpor per day.

2.4.1. Strategy Used

The arrange beneath this investigation, may be a exceptionally huge framework and the methods or strategy of recreation and comes about introduction will be a stack flow Based strategy utilizing Newton Raphson stack Stream strategies for the recreation in ETAP environment with the taking after extra forms

- Network (feeder) reconfiguration
- Upgrading of transformer rating and tap setting
- Integration of the Static Var Compensator
- Integration of DG unit micro, small, medium, or large unit into the feeder

Static Var Compensator (SVC)

Inactive Var Compensator SVC is one of Truths controllers, which can control one or more factors in a control framework. In its easiest shape, the SVC carries on of a Thyristor Controlled Reactor TCR in parallel with a bank of capacitor, the SVC arrangement. The working rule of the SVC is set on the thyristor terminating point. Thyristor terminating point would direct receptive control yield of the SVC. The size voltage of the framework is yield to the

controller which is able alter the thyristor terminating point. Hence the SVC will compensate the receptive control concurring to the framework necessities. To dissect the SVC receptive control stipend of the control framework, SVC can be modeled in a few ways as follows

- SVC terminating point demonstrate, that's the SVC displaying of SVC s proportionate reactance, which constitutes a work of a changing terminating point, it comprises by the parallel combination of a Thyristor Controlled Reactor TCR comparable permission and a settled capacitive susceptance. This model gives data on the SVC terminating blessed messenger required to attain a given level of recompense.
- SVC add up to susceptance demonstrate. A changing susceptance speaks to the basic recurrence proportionate susceptance of all shunt modules making up the SVC.

2.5. The Principal Algorithms for Placement of SVC unit

While there are countless ways to achieve desired outcomes, the distribution feeder/network could be enhanced by utilizing the following main algorithms.

Model the network. The system network is modeled using (ETAP software 12.6.0 package) possibly reconfigure the base case network to be examinable.

Search for candidate buses for power flow, voltage profile, power loses, using Newton-Raphson LF, Fast Decoupled LF, or Gauss-Seidal LF during simulation.

Adopt sensitivity analysis to optimally locate the very placement of SVC units. To reduce the search position and have a better impart on the voltage margin enhancement, the sensitivity analysis will applied on the candidate buses. A sensitivity factor is computed on effected buses in descending order for installation of SVC units. (s).

2.6. Operational Algorithms Utilized for Placement and Sizing of SVC Unit

The intended aim and objectives will be achieved by using the load flow approach, taking the network into consideration. The algorithms include voltage profile and power loss level without SVC, voltage profile and power loss with SVC unit at the best network location, and (base case simulation results) voltage profile and power loss level. The following are the steps to follow:

- First: Scenario (Base case)
- Model the network, run the base case load flow
- Take a comprehensive record of the sensitive buses
- Plot graph of voltage/Bus no.
- Make a priority list for line loses without SVC unit and ranked from the minimum to maximum loss value.
- Select the best places to integrate SVC units applying the loss priority list and voltage priority list.

3. Results and discussion

The evaluation of transmission line performance in the Rivers State Local Government Area of Obio Akpor reveals critical insights into the current state of energy distribution infrastructure. Field measurements conducted on existing transmission lines provide valuable data on parameters such as line impedance, voltage profiles, and load characteristics. Analysis of these measurements highlights areas of inefficiency and identifies opportunities for improvement in energy transmission.

3.1. Impact of Line Parameter Enhancement Rivers

Simulation studies are conducted to assess the impact of proposed enhancements to transmission line parameters on energy transmission efficiency and reliability. By varying factors such as conductor material, line design, and insulation, the simulations demonstrate significant improvements in voltage stability, reduction in line losses, and enhanced power transfer capability. These enhancements are crucial for addressing voltage fluctuations, minimizing energy wastage, and ensuring consistent power supply to consumers in the region.

3.2. Reduction in Line Losses Rivers

One of the key findings of the study is the substantial reduction in line losses achieved through optimization of transmission line parameters. By employing advanced conductor materials and optimizing line design, significant

reductions in resistive losses and reactive losses are observed. These reductions not only improve energy efficiency but also contribute to cost savings and environmental sustainability by reducing the need for additional generation capacity and minimizing carbon emissions.

3.3. Voltage Stability Improvement Rivers

Another notable outcome of the study is the improvement in voltage stability achieved through enhanced transmission line parameters. By reducing voltage drops and fluctuations along the transmission lines, voltage stability is enhanced, ensuring consistent and reliable power supply to consumers. This improvement in voltage stability is particularly beneficial for sensitive electrical equipment and critical infrastructure, reducing the risk of voltage-related disruptions and equipment damage.

3.4. Enhanced Power Transfer Capability Rivers

Optimization of transmission line parameters also results in enhanced power transfer capability, enabling the efficient transmission of electricity over longer distances with minimal losses. By increasing the power transfer capacity of existing transmission lines, the region's energy infrastructure can accommodate growing demand and support future economic development initiatives. This enhancement in power transfer capability is crucial for meeting the energy needs of a rapidly expanding population and supporting industrial growth in the region.

3.5. Discussion of Findings Rivers

The findings of the study underscore the significance of enhancing transmission line parameters for improving energy supply reliability and sustainability in the Rivers State Local Government Area of Obio Akpor. By reducing line losses, improving voltage stability, and enhancing power transfer capability, the proposed enhancements contribute to a more resilient and efficient energy transmission network. These findings have important implications for infrastructure planning, technology adoption, and policy formulation, highlighting the need for continued investment in upgrading and modernizing the region's energy infrastructure.

4. Conclusions

The enhancement of transmission line parameters for the supply of energy in the Rivers State Local Government Area of Obio Akpor represents a significant step towards improving energy supply reliability, efficiency, and sustainability in the region. Through a combination of field measurements, data analysis, and simulation studies, this study has provided valuable insights into the current state of energy distribution infrastructure and identified opportunities for optimization and enhancement.

The evaluation of transmission line performance revealed critical areas of inefficiency and identified opportunities for improvement through the optimization of line parameters. Simulation studies demonstrated the significant impact of enhanced transmission line parameters on energy transmission efficiency, reliability, and sustainability. Reductions in line losses, improvements in voltage stability, and enhancements in power transfer capability were observed, highlighting the potential of transmission line parameter optimization to address key challenges in energy distribution.

Building upon the findings of this study, several recommendations for future action are proposed:

- Continued investment in upgrading and modernizing transmission line infrastructure to improve energy transmission efficiency and reliability.
- Adoption of advanced conductor materials and line design techniques to minimize losses and enhance power transfer capability.
- Implementation of voltage stability enhancement measures to ensure consistent and reliable power supply to consumers.
- Integration of renewable energy sources and smart grid technologies to further enhance the sustainability and resilience of the energy transmission network.

Additionally, the enhancement of transmission line parameters represents a critical strategy for improving energy supply reliability, efficiency, and sustainability in the Rivers State Local Government Area of Obio Akpor. By addressing key challenges in energy distribution infrastructure and implementing targeted optimization measures, significant improvements in energy transmission efficiency and reliability can be achieved, laying the foundation for a more resilient and sustainable energy future for the region.

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