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Research article

Investigating the effects of bus numbering in a radial transmission network using load-flow study

Ademola Abdulkareem [a], A.S. Alayande [b], T.E. Somefun [a,*], E.V. Ette [a]

[a] Electrical and Information Engineering Department, College of Engineering, Covenant University, Ota, Nigeria
[b] Department of Electrical and Electronics Engineering, Faculty of Engineering, University of Lagos, Nigeria

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ABSTRACT

This paper explains the effects of bus numbering using a load-flow study to investigate the Nigerian 330 kV radial transmission networks. The objectives of this research include the Newton-Raphson-based load-flow analysis and verification of power losses. The simulation of the load-flow analysis is carried out using the software of Power World Simulator and MATLAB, while verification of power losses is simulated with only MATLAB software. The Nigerian 330-kV transmission lines used in this study are radial and are overloaded; thus, it has been subjected to numerous studies covering many areas as to how improvements can be made. All these studies aimed at increasing the efficiency of the network and reduce real and reactive power losses. In this study, analysis is carried out on the failure to convergence; the result of load-flow as obtained for the 28-bus power system of the Nigerian 330-kV network using two different bus identification numbering sequence types. The results of the Newton-Raphson load-flow solution in Power World Simulator and MATLAB platform obtained for each of the two bus identification types revealed the convergence failure in one identification model numbering type. This result's inconsistency further necessitated the study of load-flow analysis on the Nigerian 330-kV network for other different bus identification numbering types as reviewed from past work for case studies. The same bus data and transmission line data obtained from PHCN are used for all the bus numbering model types generated in the study. The results revealed variations in the real and reactive power losses and the number of iterations in solving each case. Besides, the study discovered that the failure in convergence comes from the power solution method's failure (software) used, hence, a code-based platform should be used for verification.

1. Introduction

The demand for electrical energy has always been on the increase simply because of population growth and industrial development in developing countries [1]. Hence, the operation of transmission lines at maximum efficiency is very important [2, 3]. Power system quality and its analysis are irreplaceable when it comes to the generation, transmission, and distribution of electrical power either in small or large-scale power system networks. However, today's power system is a complex network of transmission lines interconnecting the generating units of various locations to the major load points. The load-flow analysis on power systems provides various iterative techniques of solution that determine the steady-state of line flow and losses, line currents, and line voltages for the best operation and planning of power system [4]. This analysis cannot be overemphasized in a country like Nigeria where the generation, transmission, and distribution of power have been a major setback in the nation's development.

The literature on load-flow solutions (Newton-Raphson or Gauss-Seidel) analysis performed on Nigeria 330kV network is almost in flux, but a regular problem facing researchers for so long is finding the solution to the inaccuracy in the correct assessment of the flow of active and reactive power and line losses [5, 6]. In most cases, the magnitude, as well as the location of the voltage, violated buses are fairly determined, but there are discrepancies in the values of active and reactive powers and the overall losses load flow analysis. Ignatius did a load-flow study on the Nigerian 330-kV power system and discovered that there are more than a few losses on [7]. When a load flow study is carried out, the core of the study is to find out the complex bus voltages, active and reactive power

* Corresponding author.
E-mail address: tobi.shomefun@covenantuniversity.edu.ng (T.E. Somefun).

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