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Power system analysis and integration of the proposed Nigerian 750-kV power line to the grid reliability

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Abstract

The present situation of power generation in Nigeria obviously represents a challenge to our ability for rethinking the delivery of energy at maximum efficiency. Previous research on the existing Nigerian 330-kV network grid, recommended that the network be transformed from radial to ring because of high losses inherent in it and the voltage insecurity. In this study, the existing 330-kV network was reconfigured based on the identified regions mapped out for upgrade to form a ringed 750-kV super grid. The bus voltages of some of the buses in the existing 330-kV were upgraded to 750-kV and new transmission lines added to create an integrated super grid with a ring

structure as compared to the radial nature of the existing 330-kV grid. These proposed buses have been selected for upgrade based on the fact that they are positioned in critical areas within the topology of the grid that transforms the existing radial structure to a ring one. The method is also cheaper than making the entire network a 750-kV system. Load-flow analysis was carried out on the existing 330-kV Nigerian Grid and the proposed Nigerian 750-kV integrated into the existing grid using Newton–Raphson algorithm. The results analysis of the new network revealed a significant reduction of 30.2% power loss. This was validated using the code-based MATLAB and Power World Simulation model-based software. Contingency analysis was also carried out on both grids using the Power World Simulator. The study revealed that the 750-kV super grid was able to mitigate the losses experienced on the existing grid significantly with better voltage profiles in all the buses. It also revealed that the new network (330-kV and 750-kV integrated) performed better to the single line contingency analysis with less violations occurring and no unsolvable cases.

Introduction

The operation of transmission lines at high voltage level, above 500-kV, has been embraced by the developed countries as a standard [1,2,3,4,5]. A reliable power supply is an essential part of any nation thriving toward economic growth and national development. Nigeria, being the giant of Africa and home to the largest economy in Africa as of 2014 [6], cannot boast of a steady power supply due to the state of the power sector operations. It is no longer news that the national power system has been identified with frequent outages. This advertently caused the cost of living to increase as citizens now have to consider the cost of running their private generators. Furthermore the negative role it plays in industrial and economic development has to be considered. Industries and companies refrain from production activities in the nation because of the outrageous cost of running their power sources. This has also caused some of the existing industries to collapse due to the unavailability of electricity thereby resulting in the loss of jobs in those industries and further increase in the hardship faced by the populace of this country [7].