RELIABILITY EVALUTION OF AN EMBEDDED POWER SYSTEM FOR AN IMPROVED VOLTAGE PROFILE IN THE NIGERIA POWER DISTRIBUTION SYSTEM

RESEARCH PROPOSAL

BY

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BACKGROUND OF STUDY

An embedded power system in a power distribution network refers to a localized or decentralized power generation. Instead of relying solely on a centralized power plant to generate electricity and distribute it across a wide area, embedded power systems involve small-scale power generation sources located close to or within the consumer's premises. Also known as distributed generation has been growing rapidly in deregulated power system due to its potential solution to meeting localized demand at distribution level and mitigating limited transmission capacity from centralized power stations (Basudev & Dr Bimal, Nov. - Dec. 2013).

Embedded power systems utilize mostly renewable energy sources which are connected to the distribution network with the aim of reducing losses within the network and to obtain significant improvement in the power quality and the system reliability (Ekwue & Akintunde, 2015). Components of embedded power system includes Renewable Energy Sources, Energy Storage Systems, Power Inverters and Converters, Smart Grid Technology. Its classification is mostly according to capacity, ownership and functionality in supporting the national grid, (Sethi & Nigam 2016).

Evaluating the reliability of an embedded power system of a distribution power network involves assessing its ability to deliver electricity consistently and without interruptions to the connected consumers. Reliability is a critical aspect of any power distribution system as it directly impacts the quality of service provided to customers and the overall economic and social well-being of the community (Nick, Ron, Peter, Daniel Kirschen, & Goran, 2008).

The reliability computation of a network depends on the reliability of components included in the network. Each component has two states, an operating state and a failed state which determines the status of the network (Modu, Ishaku, & Musa, February 2020).

AIM AND OBJECTIVE

The purpose of this research work is to evaluate the reliability of an embedded power system for an improved voltage profile in the Nigeria power distribution system with the following objectives:

1. Identifying and analyzing potential failure modes in Nsukka Urban Distribution Network

2. Determining the Reliability of the system with and without an embedded system
3. Obtain Reliability metrics of components through statistical methods and historical data of the network
4. Conduct system level analysis to determine the overall Reliability of the embedded power system
5. Analyze the impact of components failures in Distribution network.

RESEARCH METHODOLOGY

This study is a continuation of work done by Stephen (2022). Nsukka Urban Distribution Network was Modelled and Simulated with an Embedded Power System for Improvement of Voltage Profile in the Nigeria Power Distribution System.

Assessing the reliability of the distribution network with embedded solar Photovoltaic (PV) generator involves a comprehensive methodology that will consider various factors and performance indicators. This study will concentrate on three distribution feeders, Onuiyi feeder, Wilson feeder and UNN feeder according to Stephen (2022). The method adopted to determine the objectives of this study will include the following as being evaluated using ETAP software.

Identify System Components: This will be achieved by understudying the components of the distribution network, including the embedded solar PV.

Data Collection: Data on system design, equipment specifications, historical performance records, and outage data will be gotten and information on the capacity, efficiency, and maintenance history of the embedded PV system.

Define Reliability Indices: The reliability indices to be used for assessment will be determine. Common indices include: SAIDI (System Average Interruption Duration Index): Total duration of interruptions per customer served by the network over a specific period. SAIFI (System Average Interruption Frequency Index): Average number of interruptions experienced by each customer over a specific period. CAIDI (Customer Average Interruption Duration Index): Average outage duration per customer affected during an interruption. MAIFI (Momentary Average Interruption Frequency Index): Average number of momentary interruptions per customer over a specific period. Other methods for the reliability evaluation will include Modeling and Simulation, Failure Mode and Effects Analysis (FMEA), Fault Tree Analysis (FTA) and Risk Assessment and Mitigation.

EXPECTED RESULTS

The expected results for reliability evaluation typically include various metrics and indices that provide insights into the system's performance and availability. The specific expected results and their target values may vary depending on the regulatory requirements, the criticality of the power supply and the service level agreements with consumers. Regular reliability evaluations help utilities optimize their infrastructure, plan maintenance activities, and enhance the overall performance of the power distribution network; common expected results will be on: System Availability, Mean Time Between Failures (MTBF), Mean Time to Repair (MTTR), Failure Rate, System Reliability Index (SRI), Customer Interruption Metrics, Fault Clearance Time, Redundancy Analysis, Load Shedding Performance, and Risk Assessment.

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