IMPACTS OF INCORPORATING DISTRIBUTED GENERATION (DG) TO THE RELIABILITY OF ELECTRIC DISTRIBUTION NETWORK USING MONTE CARLO SIMULATION (MCS)

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Abstract

Reliability evaluation is one of the primary techniques for assessing the stability of the distribution network. Placement of distributed generation (DG) into the network provide a significant impact on reliability performance. Commonly, more research focuses on voltage and power loss-based placement rather than reliability-based. Therefore, this paper presents the impact of the placement of two different DG size scenarios based on reliability effectiveness. IEEE-30 bus system will be used to simulate the reliability of the network. Monte Carlo Simulation (MCS) will be implemented to determine customer-related as well as system reliability performance. Based on the output of the simulation, the values of the reliability indices (SAIFI, SAIDI and CAIDI) give a different result between scenarios as impact of the placement of DG to the network.

1 Introduction

Electricity is a fundamental part of human life. It is used to power machines and devices, including lights, appliances, and electronics. In order to use electricity, customers must have access to electric power. Therefore, ensuring that customers receive a continuous supply with minimal downtime in the process will be a challenge. Nevertheless, access to and stable electricity supply is vital to a nation's economic growth, maintaining and improving the living standards of billions of people [1], [2].

The reliability of power systems is crucial to current power system planning, design, and operation. The reliability problem is measured by the power interruption problems and is a big concern in daily life [3]. Interruptions to the customer power system are usually found in distribution network operators (DNOs)[4]. According to [5], DNOs aim to increase the availability of power supply services by delivering a performance that is reliable and within target while reducing operational and maintenance costs to provide consumers with reasonable tariffs.

The reliability of a power system can be improved by adding generating capacity, enhancing the operation and maintenance of generating plants, or by adding distribution systems that can distribute power more reliably. A distributed generation (DG) system is a power system where power is generated near where it will be used. This contrasts with a centralized generation system where power is generated at a large facility and transmitted to users. DG systems have several advantages over centralized systems. One of the most important is that DG systems are more efficient. This is because the losses that occur in the transmission and distribution of power are minimized. In addition, DG systems are more flexible since they can be set up to meet the specific needs of a particular area. Finally, DG systems are more environmentally friendly since they do not rely on fossil fuels, for example, wind-powered and solar cell generation.

The concern of "placement of DG" is raised since DG connected at some network sites will have a more significant impact than DG connected at different network locations [5]. Whether or not it is located optimally, DG can (substantially) improve network voltage regulation (especially in weak networks), minimise system losses and enhance overall network performance, along with system reliability level. Studies have developed a variety of methods for incorporating DG, which is often placed at the weakest point in networks and uses voltage sensitivity[6]–[13] or loss sensitivity [9], [14]–[19] as the primary determining factor on size and location of the DG. A very handful of studies, including [5], [20]–[24], have recently focused on the issue of (optimal) placement and operation of DG systems with the main target of improving the reliability and performance of the network.

Power system reliability indices can be determined by using various methods. A review by [25]–[27] indicates that analytical optimisation and heuristic optimisation or hybrid optimisation are two commonly used optimization techniques to find the optimal placement of DG. The analytical approach used mathematical techniques [28] and typically concentrated on a mean value, disregarding future performance assessments [29]. A complex network is frequently simulated using the Monte Carlo method, a probabilistic simulation [30]–[32]. It allows analysts to simulate the actual process and wide range of possible input with all components that should exist in the network and are needed. Therefore, to fill the gap, this paper focuses on MCS strong capability and analyses reliability