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RESEARCH ARTICLE

Investigation and Study of High Voltage Capacitor Bank Techniques for Voltage Drop Improvement in 22-kV Distribution Line

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ABSTRACT Voltage drop in distribution lines contributes to power losses, leading to a decrease in the overall efficiency of the electrical power system. In this paper, we investigate methods to improve voltage drop through capacitor bank allocation techniques, specifically installation at the end of the distribution line, the 1/2-kvar rule, and the 2/3-kvar rule. In the case study, a 22 kV overhead distribution line in Thailand is utilized as a model to analyze voltage drop improvement. The study is conducted using PSCAD software to simulate and evaluate the effectiveness of various capacitor bank allocation techniques in enhancing voltage drop in the distribution line. In addition, the impact of capacitor bank placement and sizing on voltage drop mitigation in a distribution line is analyzed through a proposed mathematical framework. This analysis considers the interaction between reactive current compensation and impedance of a distribution line, ensuring an optimized approach for capacitor bank deployment to enhance voltage drop. The results emphasize that the capacitor bank installation at the end of the distribution line yields the most substantial voltage drop improvement. This is attributed to the utilization of larger capacitor bank capacities compared to the 1/2-kvar and 2/3-kvar methods. Furthermore, the mathematical analysis confirms that both the placement and sizing of capacitor banks play a crucial role in voltage drop mitigation.

INDEX TERMS Voltage drop, capacitor bank, capacitor allocation, distribution line, mathematical.

I. INTRODUCTION

Increased energy demand is caused by the expansion of industry and the socioeconomic development of a population, which must be met by electricity provided by power plants. To provide electrical energy to users, the electric power system is carried out, divided into four major segments i.e., generation, transmission, distribution, and consumers. Thus, an increment in the power generation requires greater effort from the transmission systems to increase the capacity of electric power transfer to meet this high demand. In contrast, the transmission systems are well notable for their high R/X ratio, resulting in large voltage drop along the transmission lines, leading to heavy power losses [1], [2]. Thus, it becomes imperative to make the transmission lines efficient and effective.

To achieve the reliability, efficiency, and service quality of electric power systems, voltage drop minimization have recently assumed greater significant. The necessary for voltage drop improvement in electric power systems has inspired several strategies. In this terms, various research articles on improving the voltage drop have been performed by voltage

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