Power System Operation Cost Optimal Location

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Research Article

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Abstract: For voltage control and system stability, reactive power is essential. Electric power systems use a variety of Volt/VAR techniques to keep the voltage profile within a predetermined, acceptable range, providing stability, reliability, and economic benefits. Reactive power has traditionally been generated by large-scale synchronous generators or distributed capacitor banks to allow proper transmission and distribution level system management, while it may also be used to reduce overall system running costs. The expenses related to acquiring and using fuel to generate electricity in power plants are referred to as fuel costs or operating costs of a power system. These costs may vary depending on the fuel type (coal, natural gas, oil, or renewable sources) and the efficiency of the power generation process. This operational cost decrease will be accomplished by altering nodal reactive power, which will impact network power flow. The main objective of this study is to determine the best course of action in a system where variable reactive power mostly reduces the portion cost. The performance and applicability of the proposed approach are validated using IEEE 30-bus.

Keywords : Reactive Power, Operation Cost

1. Introduction

2. Since many residential and commercial utilities in the power system network rely on reactive power management, the significance of power system operation costs is expanding along with the demand for electrical power. It is necessary to create energy in a more economical, dependable, and efficient manner. Technologies like static voltage compensation (SVC) and flexible AC transmission systems (FACTS) are used in efficient electrical energy delivery to maintain high power factor, low transmission losses, and voltage stability. In the power system network, reactive power is essential [1].

Reactive power is regarded as the crucial component of the auxiliary service that facilitates the transfer of power from the site of generating to the end user. Voltage support, spinning reserve, non-spinning reserve, replacement reserve, and load control are a few examples of services. Because it influences the voltage profile throughout the system, increases system reliability, and ensures power flow, reactive power has a significant impact on actual energy transfers and power system security. Reactive electricity should not be transported via the network [1]. As as a result, ancillary services—such as power frequency control, power balance, regulation and operating reserves, voltage control, and supply restoration—that are typically acquired through short-term competitive market mechanisms are becoming increasingly significant in the process of assisting with the grid's integration of renewable energy sources. Reactive electricity quantity cost and reactive power capacity cost are the two categories of reactive power cost [2]. When the marginal income and marginal cost of reactive electricity are identical, the maximum profit may be made [3]. A. Device or System An explanation The management and pricing of reactive electricity were the main topics of the earlier research. A model to assess the economical price of reactive power is proposed by the research in [4]. Reactive power is designed to assist an electrical network, and its price provides system support from both an operational and economic standpoint. In [5], this was shown. It has been suggested that reactive power pricing include the generator's operating costs as an auxiliary service for reactive power production costs. Using a series of sigmoidswitches that integrates additional equations into the issue formulation, a novel complete Newton approach is presented to describe the reactive power production limitations in the power flow problem [6]. In [7], a straightforward technique for maximizing the solar system's electricity distribution to the utility grid is proposed. To address the best reactive power flow in wind generating, three different types of models are proposed. unified system. The models are used in an IEEE 14-bus system that has been modified. Model characteristics are examined and contrasted based on simulation findings [8]. [9] provides an overview of the potential, constraints, benefits, and drawbacks of reactive power control for wind turbines. The writers in [10] propose a mechanism to compensate the auxiliary services of reactive power support and generating reserve based on the value that generators provide to the power system. A comparison of traditional equipment like capacitor banks and distribution generating units based on renewable resources with the supply of reactive power support ancillary services in distribution networks is shown in [11]. To quantify the variation in reactive power resource value, an analogous reactive power compensation approach has been enhanced in [12]. In [13], the issue of reactive auxiliary service price is discussed and framed as a shared costallocation problem. The degree to which auxiliary services' power rates may be predicted over a 24-hour period is shown in [14]. In [15], the developed techniques of defining a payment for power stations' management of voltage and reactive power are described. In [16], it was suggested that the d-q theory be used to manage the active and reactive power between the inverter and the utility grid. In [17], reactive power deficit and related voltage violations resulting from reactive power source failures are taken into consideration. In [18], a comprehensive model for integrating the reactive power restrictions of distributed generation (DG) units into the power flow formulation is provided. In [19], a reactive power compensation control approach is introduced. In [20], the impact of reactive power shortage on system reliability is represented by new reliability indices that take into account reactive power deficit and the related voltage violations brought on by reactive power source failures. In order to accomplish quick reactive power regulation on synchronous generators, a new correction approach is presented in [21]. Particle swarm optimization and its variations are used in [22] to determine the ideal real and reactive power to control system power congestion. In [23], a technique for determining the ideal real and reactive power that reduces the operating costs of the power system while maximizing societal value is provided. In [24], a mathematical model for the price structure of reactive electricity based on several cost components is created. A compromise programming technique based on a modified optimum power-flow model is used in [25] to build a competitive market for reactive power ancillary services. In [26], a power flow simulator is used to offer an inexpensive reactive power dispatching technique. In [27], a methodology for determining the best real and reactive energy storage and embedded wind generating system is put forward. [28] presents a reactive power management framework that maintains active and reactive power at economical dispatch while protecting voltage stability at the highest margin. In [29], a unique mathematical method for voltage magnitudes is used to solve the optimum reactive power dispatch issue. The principle of marginal cost at different loads is used in [30] to assess the cost of reactive power. This paper discusses two ways to store reactive power cost: adding reactive power cost to actual power cost and penalizing load power factor. Furthermore, it is said that the development of reactive power results in a reduction in actual power generation. In order to recoup actual power output, an opportunity cost of reactive power is thus added. Additionally, linear programming methods are used to analyze the cost of capacitive reactive power and its allocation in order to get the lowest possible cost. Renewable resources might provide distribution networks with reactive electricity, lowering the cost of operating the transmission system, enhancing system security, and lowering the cost of ancillary services [31]. The availability of wind and solar sources presents several issues for reactive power regulation and distribution systems, particularly since these sources run at maximum tracking power points that are influenced by weather conditions. In order to provide flexible operation control, power electronic devices often provide the interface and connection of DG units in microgrids to general grids. Reactive power compensation is one of the quality issues these devices pose while supporting load and voltage, however. In addition to droop control, reactive power/voltage and active power/frequency are the primary methods for microgrid power

3. Theory of Proposed Idea

4. The objective of the suggested approach is to identify the best bus that ensures the lowest

control [32]. In [33], active power droop control was introduced, which uses reactive power integration to reduce voltage. Microgrids use an active power filter in this control mechanism to get reactive power harmonic correction. In microgrids, all of these control strategies are used to accomplish active power adjustment.

A. ModelOutlineandFormulationofOptimumReactive Power Calculation In Power System

B. Finding the optimal reactive power for each bus in the system that produces the least expensive system operation is the aim of this article. To put it another way, the nodal reactive powers are modified to reduce the system's actual power generating costs. Manufacturers give synchronous generator capability curves in standard condition. They are used to load synchronous generators with varying operational loads while staying within the parameters of the design. A synchronous machine's nominal capacity is often measured by MVA at a certain voltage and power factor (typically 85–90% of lead) where the machine may operate continuously without experiencing an excessive temperature increase. The nominal MVA machine limitations and turbine capability determine the synchronous machine's real output power. Only when there is sufficient reactive power to sustain it can an asynchronous generator generate actual electricity. Otherwise, the security system policy prevents the generator from producing actual electricity [30]. The actual and reactive power capacities of generators are both maximum and lowest. Operating with a lagging power factor is linked to the greatest reactive power capacity. The maximum reactive power that the generator can withstand is equal to its lowest reactive power capability.

overall system operating costs when Stated differently, the nodal reactive powers are modified to reduce the actual power production cost of the system. The total of each unit's expenses, each of which is shown as a second-order function of its actual power production, is the objective function. Pi stands for the actual power production of the unit I, and the constant cost coefficients are

In order to do this, an anodal reactive power variable was added to the optimum power flow problem, and the best buses with the most effect on reducing system operating costs were found. After testing the suggested model on IEEE 30 bus standard systems, the bus number 8 was identified as the position with the lowest operating costs.

Conclusions

Reactive power is a key component in lowering system losses, therefore minimizing the power system operation cost objection function is essential for economically operating the power system. This paper's main objective was to identify the best bus for a power system in order to reduce the overall cost of system operation.

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