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Improvement of transient stability using STATCOM during faulty condition

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Abstract

This study offers insights into how STATCOM is integrated into smart grids. Transient stability is a critical concern that is addressed by the incorporation of Static Synchronous Compensator (STATCOM) technology in power systems. Maintaining transient stability becomes critical when dealing with dynamic disturbances like faults or abrupt changes in load. By dynamically managing reactive power injection or absorption, STATCOM actively contributes to this stability by utilizing the concepts of a voltage source converter. This method reduces the possibility of voltage instability by enabling quick and accurate voltage management during transient events. The vital role that STATCOM plays in improving transient stability is examined in this abstract, which also provides insights into how it can strengthen power grids and increase overall system resilience. In this paper, we have considered a three bus system, a fault is introduced at bus three. This bus system is considered with and without STATCOM. The simulation results show its effectiveness in improving the transient stability. The quantity demand and investment in research and development, while the other model focuses on a more realistic relationship between the quantity y demand and the price.

Subject Classification: *93-XX.*

Keywords: *STATCOM, Transient stability.*

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1. Introduction

Stability of the power system landscape is an ongoing problem, especially in the case of transient occurrences characterized by abrupt disturbances like faults or sharp swings in load. Maintaining the synchronous operation of generators and averting cascading failures require ensuring the transient stability of power systems [1]. The potential of Static Synchronous Compensator (STATCOM) technology to improve system stability has drawn attention to addressing this challenge [2]. The technology behind STATCOM is voltage source converter technology, which enables reactive power to be controlled dynamically [3-4] This feature becomes especially important when it comes to quickly controlling voltage levels during brief occurrences, which reduces the possibility of voltage instability. The ability to dynamically adjust reactive power in power systems is the foundation of a Static Synchronous Compensator's (STATCOM) operation [5]. Because STATCOM is built on voltage source converter technology, it can actively add reactive power to the electrical grid or absorb it [6]. In reaction to shifting system conditions, STATCOM may instantly control the reactive power flow by adjusting the output voltage and current [7-8]. When transient events like faults or abrupt load fluctuations occur, STATCOM quickly modifies its reactive power output [9]. By keeping voltage levels within reasonable bounds, this dynamic management helps to avoid voltage instability and enhances the power system's overall stability [10]. In essence, STATCOM responds to changes in the electrical network and provides support by functioning as an accurate and adaptable compensator. In power systems, the term "transient stability" describes the system's capacity to keep generators operating synchronously in the face of abrupt and unpredictable disruptions. These disruptions, which include malfunctions or abrupt changes in load, may cause departures from the standard operating environment [11]. Making sure the generators stay in sync and keep producing power without experiencing cascade failures is the difficult part. For the electrical grid to remain reliable, transient stability must be maintained.

The paper is organized as follows. In section 2, we construct and analyze a simple mathematical model including the effect of constant quantity demand. Section 3 discusses a general competing dynamics that study the effect of quantity demand and research and development. Section 4 provides numerical analysis of a more sophisticated model, which assumes that the relationship between quantity demand and price follows the Gaussian Distribution. Finally, in section 5 we draw conclusions and consider future work.

2. Simulation Model

The modeling of three bus system is in MATLAB/Simulation 2022. In this model a three bus system consist of 2 generators of 500 KV each and 3 load system of 100 KW each as shown in Figure 1. A three phase fault is created near bus number three. The bus number three is considered because it is at middle of transmission point where STATCOM is connected. This system is simulated in two ways 1) with STATCOM is not installed 2) when STATCOM is installed as shown in Figure 2. Below listed are the step to create the model in MATLAB/ Simulink. Create a thorough mathematical model of the power system that accounts for loads, transmission lines, and generators. In the system, depict the STATCOM as a controlled reactive power source. For simulation scenarios, specify transitory events like faults or abrupt changes in load. Utilize MATLAB's disturbance models to include these occurrences into the power system. Design of STATCOM Controller: Create a control algorithm that will allow

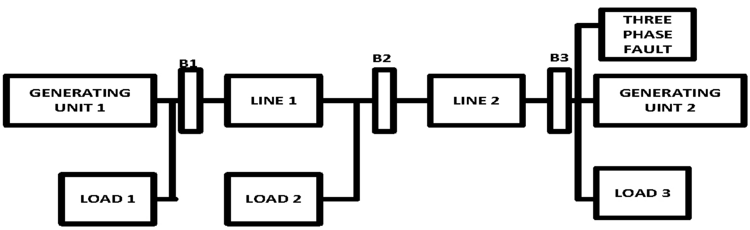

Figure 1

Single line diagram of power transmission system without STATCOM.

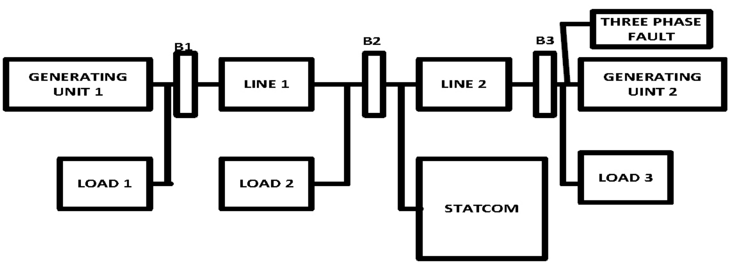

Figure 2

Single line diagram of power transmission system with STATCOM.

the STATCOM to dynamically modify its reactive power output. Using MATLAB Simulink, implement the controller while taking the system specifications and control objectives into account. Utilizing Simulink blocks, incorporate the STATCOM controller into the power system model.

3. Simulation Result

The model is simulated with and without STATCOM. The duration of the fault is from 0.01666 sec to 0.08333 sec. The simulation is running time is 0.8 second. After the simulation, the voltage magnitude, active power and reactive power is being captured. After studying the waveform, it is clearly visible that the transient stability is improved with STATCOM. When STATCOM is used, it decreases the time of variation very effectively. Figure no 3, 4 and 5 shows the result of voltage magnitude, active power and active power without STATCOM respectively..

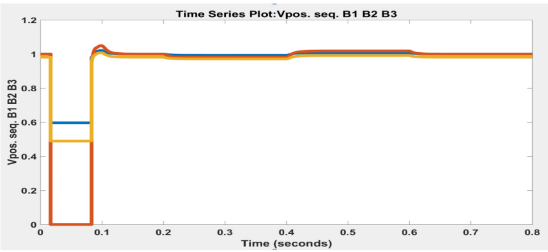

Figure 3

Voltage magnitude positive sequence for buses B1, B2, and B3 without STATCOM.

Figure no 6, 7 and 8 shows the result of voltage magnitude, active power and active power with STATCOM respectively. It is very much clear,

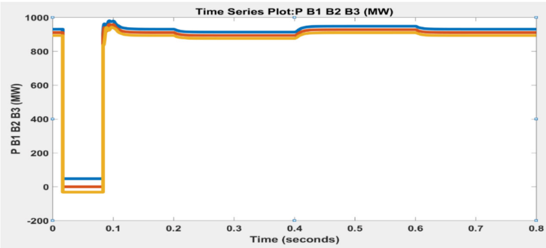

Figure 4

Active power for buses B1, B2, and B3 without STATCOM

by comparing all the figure respectively, the transients are present after the fault is clear at 0.08333 sec in without STATCOM results. The STATCOM shows its effectiveness in maintaining the transient stability of the system

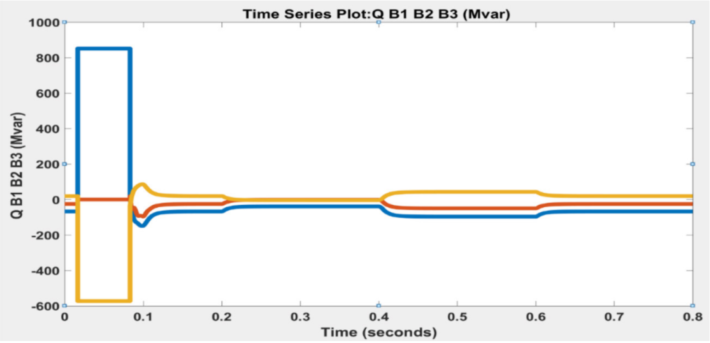

Figure 5

Reactive power for buses B1, B2, and B3 without STATCOM.

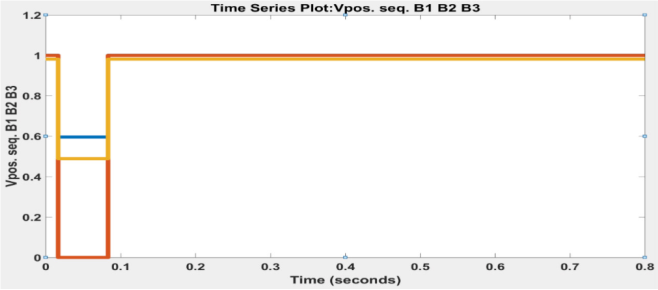

Figure 6

Voltage magnitude positive sequence for buses B1, B2, and B3 with STATCOM.

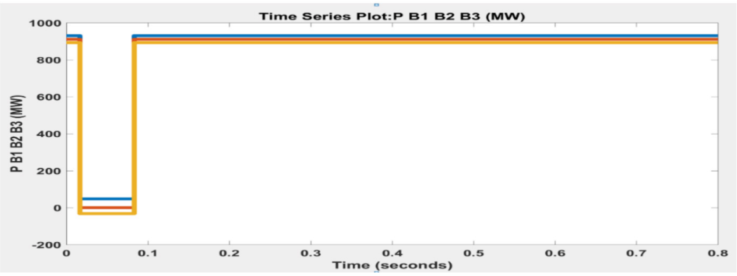

Figure 7

Active power for buses B1, B2, and B3 without STATCOM.

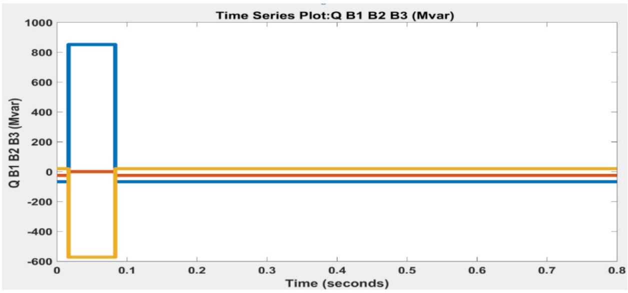

Figure 8

Reactive power for buses B1, B2, and B3 with STATCOM.

5. Discussion and Conclusion

Enhancing transient stability has been demonstrated to be possible through the simulation of the integration of a Static Synchronous Compensator (STATCOM) into a power system. To facilitate precise and quick adjustments during system disruptions, real-time reactive power regulation is made possible by the integration of STATCOMs in transient stability studies. The STATCOM shows its effectiveness to increase the transient stability of the system being consideration. The effect of STATCOMs on important factors like rotor angles and the system's reaction to disturbances can be evaluated by engineers using simulation. An important factor in preserving synchronism and avoiding excessive rotor angle deviations is the STATCOM's capacity to inject or absorb reactive power as needed. Finally, STATCOMs, through their dynamic reactive power supply, are essential in enhancing transient stability.

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