Construction and Performance Investigation of Three-Phase Solar PV and Battery Energy Storage System Integrated UPQC

1.0 ABSTRACT

This study examines the use of Unified Power Quality Conditioner (UPQC) to mitigate the power quality problems existed in the grid and the harmonics penetrated by the non-linear loads. The UPQC is supported by the Photovoltaic (PV) and Battery Energy Storage System (BESS) in this work. Generally, the PV system supplies the active power to the load. However, if the PV is unable to supply the power, then the BESS activates and provides power, especially during the longer-term voltage interruption. The standalone PV-UPQC system is less reliable compared to a hybrid PV-BESS system because of its instability and high environment-dependency. Therefore, BESS will improve the voltage support capability continuously in the longer-term, reduce the complexity of the DC-link voltage regulation algorithm, and keep producing clean energy. The phase synchronization operation of the UPQC controller is directed by a self-tuning filter (STF) integrated with the unit vector generator (UVG) technique. Implementation of STF will make sure the UPQC can successfully operate under unbalanced and distorted grid voltage conditions. Thus, the requirement of a phase-locked loop (PLL) is omitted, and the STF-UVG is utilized to produce the synchronization phases for the series and shunt active power filter (APF) compensator in UPQC controller.

2.0 INTRODUCTION

Energy efficiency is maintained by compensating the power quality problems which ensures a smooth generation of electrical energy and to encourage decarbonization of the grid. The UPQC model is formed with series and shunt APF compensator in a back to back configuration that can control both the load voltage and grid current concurrently. PV and BESS can be interfaced with the UPQC and can be a great support for continuously providing real power to the critical loads such as semiconductor industries, hospitals etc. where an uninterrupted supply of best quality power is of supreme importance. The STF integrated with the UVG technique (STF-UVG) is utilized in this work to produce the synchronization phases for the UPQC controller to address the drawbacks of the conventional PLL. This method has better phase tracking and fundamental component extraction capabilities and makes the UPQC controller superior and more reliable when dealing with unbalanced and distorted voltage grid condition.

3.0 OBJECTIVES

1. To solve the complex power quality problems, especially the long voltage interruption utilizing PV-BESS-UPQC system.
2. To produce the synchronization phases for the UPQC controller utilizing STF-UVG method.

4.0 METHODOLOGY

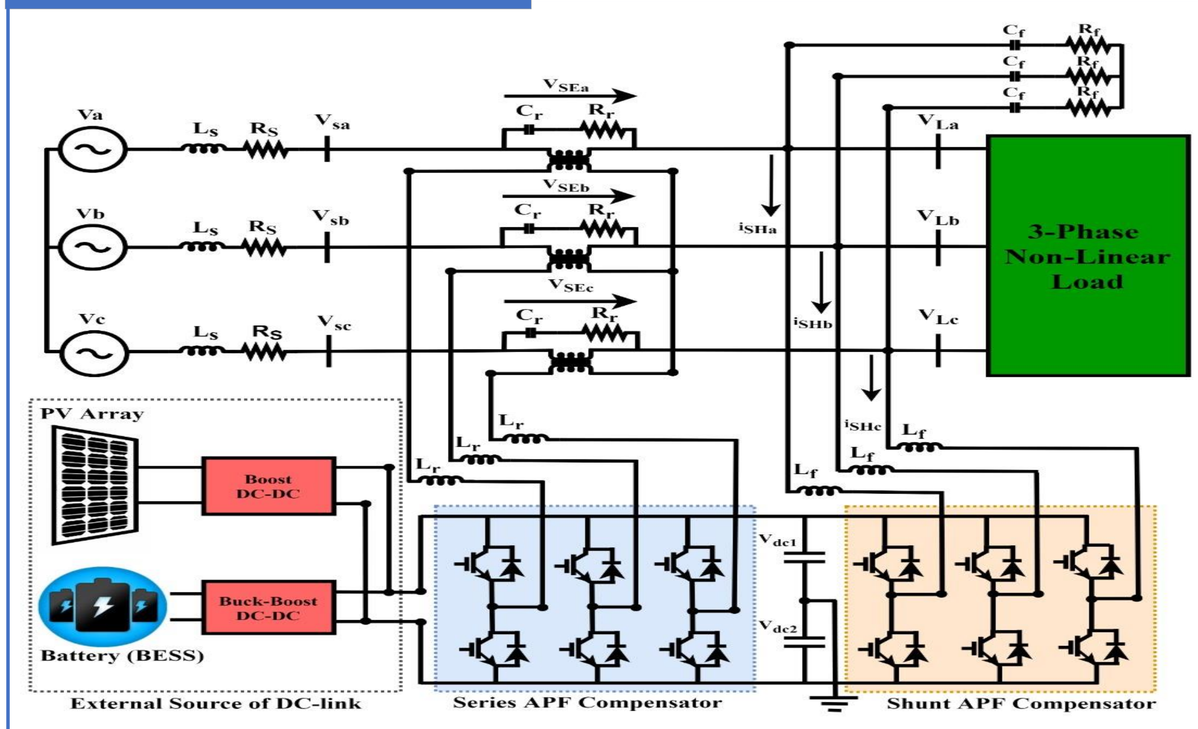

Figure 1 :UPQC system configuration

5.0 RESULTS

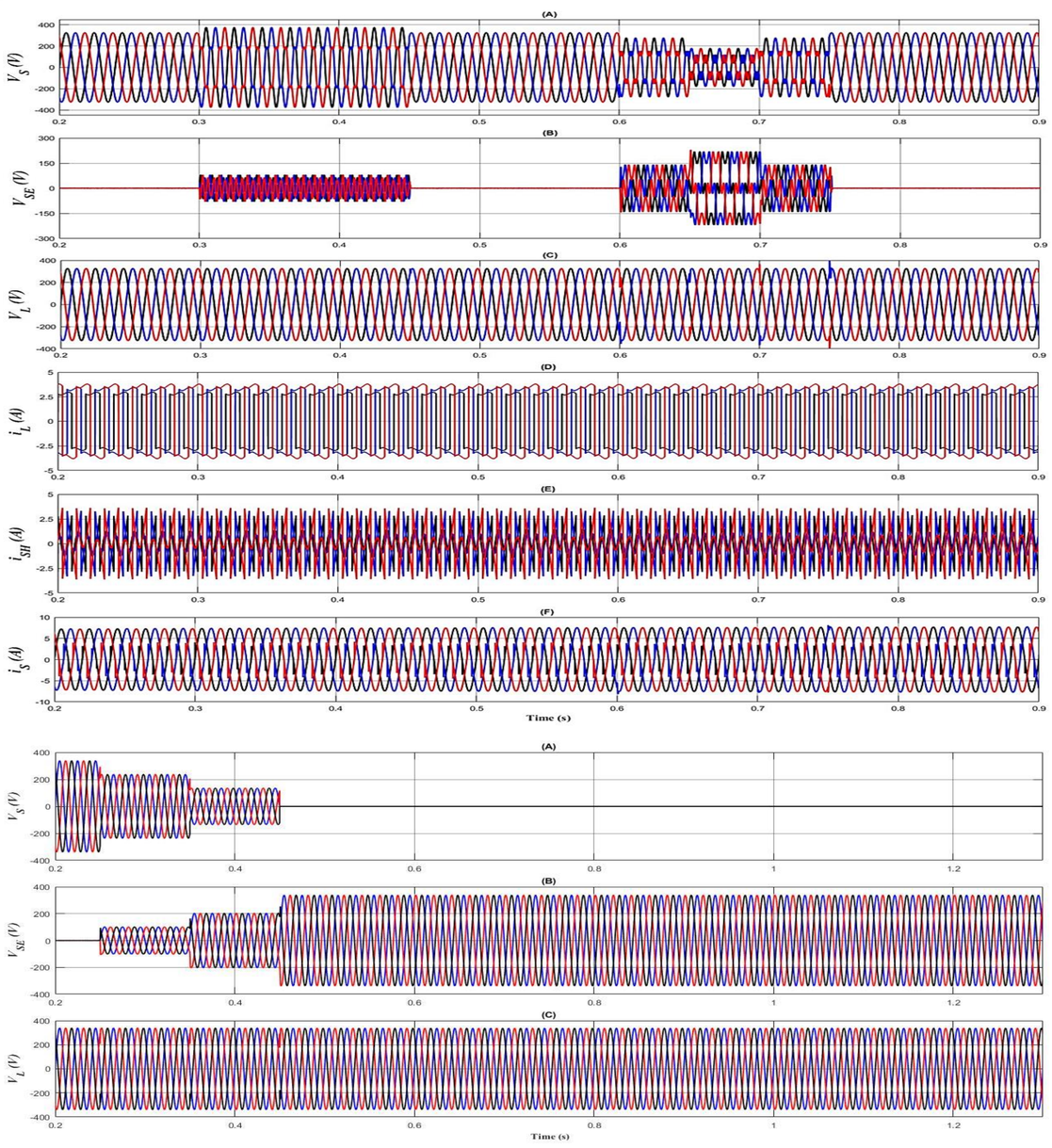

Figure 2 :Simulation result for PV-BESS-UPQC system under several power quality condition

6.0 ABB COMMERCIAL PRODUCT

Figure 3 :Hitachi ABB Power Grids active filters

7.0 CONCLUSION

The construction of three-phase UPQC has been investigated considering the condition of complex power quality problems. The STF-UVG technique for synchronization phases is applied successfully in the shunt and series APF compensator to generate reference current and voltage. It has been shown that the PV-BESS-UPQC system successfully mitigates the power quality problems. It can be concluded that the PV-BESS-UPQC can be a good alternative in the distributed generation to upgrade the power quality of the contemporary distribution system.

8.0 ACKNOWLEDGEMENTS

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9.0 PUBLICATION

1. **M. A. Mansor, K. Hasan, M. M. Othman, S. Z. B. M. Noor and I. Musirin, "Construction and Performance Investigation of Three-Phase Solar PV and Battery Energy Storage System Integrated UPQC," in *IEEE Access*, vol. 8, pp. 103511-103538, 2020.**
2. **K. Hasan, M. M. Othman, N. F. A. Rahman, M. A. Hannan, and I. Musirin, "Significant implication of unified power quality conditioner in power quality problems mitigation," Int. J. Power Electron. Drive Syst., vol. 10, no. 4, p. 2231, 2019.**