Efficient Voltage and Current Control in Hybrid Distributed Generation System using PSO DSTATCOM

Ayushi Mishra[1], Dr. Anuprita Mishra[2], Dr. Malaya Saurava Das[3]

[1]M.Tech. Research Scholar, [2]Guide, [2]Co-Guide

Department of Electrical Engineering, TIT, Bhopal

Abstract - The distribution of power from the grids are unbalanced due to single and three phase loads, which needs to be compensated. The problem occurs due to single and three phase load scenarios where system got unbalanced and voltages getting fluctuated all the time which needs to be compensated. The system proposed for making system balanced consists hybrid generation system one is conventional grid and second one is wind generation system. For regulated distribution of hybrid generation system we have integrated distributed generation units also. For making system balanced a distributed compensator is also implemented with the controlling through particle swarm optimization logic. From the simulation outcomes it is clear that the proposed system works better to make system stable.

Keywords - Hybrid Distributed Generation, PSO, DSTATCOM, Wind Generation, Dynamic Load.

I. INTRODUCTION

Power quality and reliability have become a crucial factor for the development of new technologies with the imminent deregulated environment. Distributed generation (DG) systems are expected to play a major role to meet the energy demand with clean environment. DG technologies such as photovoltaic systems, wind turbine, fuel cell, diesel engines are used in various places [1]. Wind energy has received the special attention of researchers in recent times. The advent of power electronic devices have steered a new era of power quality while integrating them with the renewable sources of energy. The renewable systems can either be interfaced with the existing grids or can be operated on a stand-alone basis. Effective capture of wind energy can definitely help to meet the energy needs as is evident in countries such as Germany, Netherlands, and Canada etc. Stand alone or isolated systems are common in islands or far rural areas where the utility grid can't reach.

A single renewable energy source may not be able to meet the load demands apart from the fact that continuous supply of energy may not be ensured (say wind is not available on a particular day in a wind farm). This makes the importance of hybrid energy systems such as wind-PV, wind-diesel along with use of battery etc. Owing to the fast controllability and response time of the diesel engines, they are quite popular for integration with wind energy conversion systems (WECS) figure 1.1 demonstrates the basic concept of hybrid distributed generation system.

As electric distribution technology steps into the next century, many trends are becoming noticeable that will change the requirements of energy delivery. These modifications are being driven from both the demand side where higher energy availability and efficiency are desired and from the supply side where the integration of distributed generation and peak shaving technologies must be accommodated

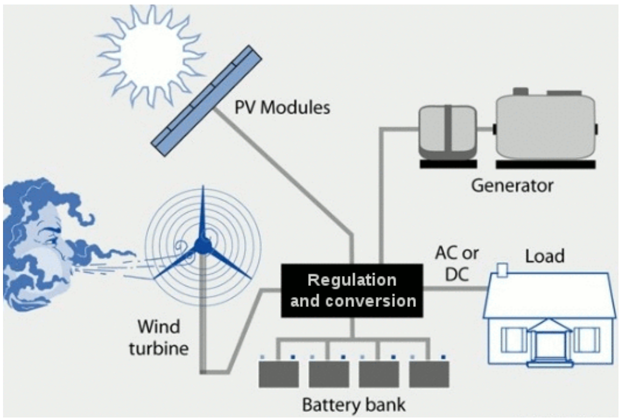

Figure 1.1 Basic Illustration of Hybrid Distribution generation system

From the customer point of view, microgrids deliver both thermal and electricity requirements and in addition improve local reliability, reduce emissions, improve power excellence by supportive voltage and reducing voltage dips and potentially lower costs of energy supply. From the utility viewpoint, application of distributed energy sources can potentially reduce the demand for distribution and transmission facilities. Clearly, distributed generation located close to loads will reduce flows in transmission and distribution circuits with two important effects: loss reduction and ability to potentially substitute for network assets. In addition, the presence of generation close to demand could increase service quality seen by end customers. Microgrids can offer network support during the time of stress by relieving congestions and aiding restoration after faults. The development of microgrids can contribute to the reduction of emissions and the mitigation of climate changes. This is due to the availability and developing technologies for distributed generation units are based on renewable sources and micro sources that are characterized by very low emissions.

II. PROPOSED METHODOLOGY

Hybrid Distributed Generation System with Dynamic RLC Load. For Compensation of voltage and current Particle Swarm Optimization (PSO)- DSTATCOM is used. For Compensation of voltage and current Particle Swarm Optimization (PSO)- DSTATCOM is used. Particle swarm optimization

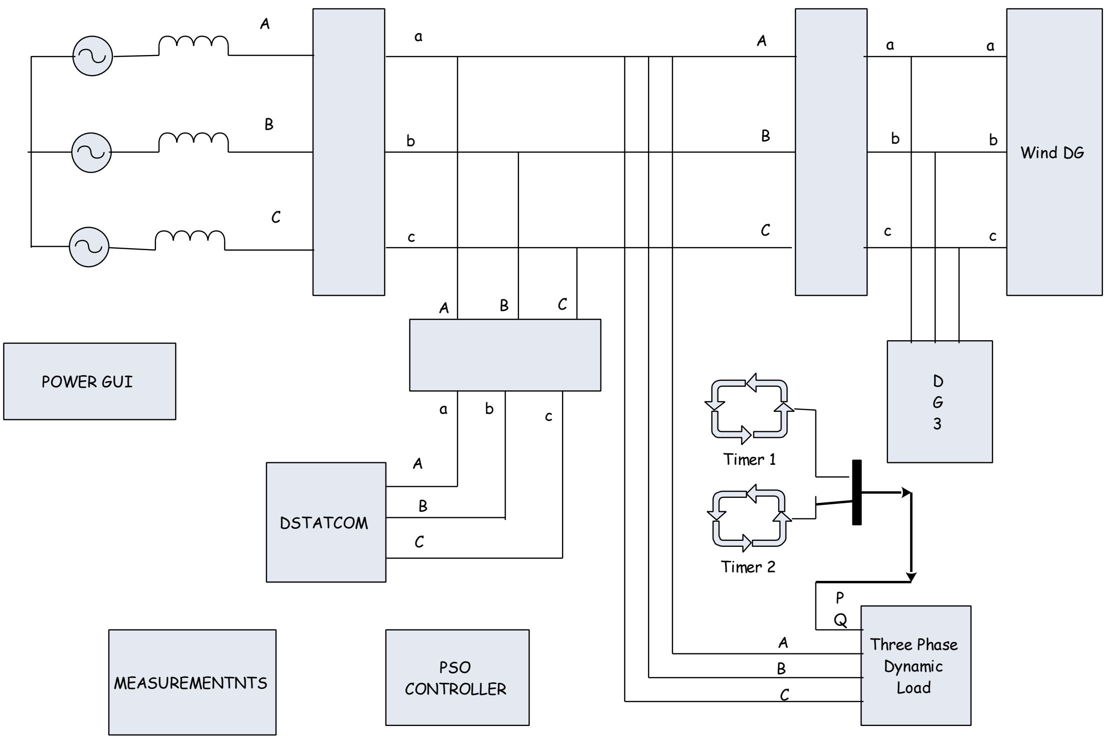

Figure 2.1 Schematic Model of Proposed Wor.

Most of the conventional computing algorithms are not effective in solving real-world problems because of having an inflexible structure mainly due to incomplete or noisy data and some multidimensional problems. Natural computing methods are best suited for solving such problems.

In general Natural computing methods can be divided into three categories:

- Epigenesis
- Phylogeny
- Ontogeny.

PSO belongs to the Ontogeny category in which the adaptation of a special organism to its environment is considered.

Particle Swarm Optimization (PSO) is a biologically inspired computational search and optimization method developed by Eberhart and Kennedy in 1995 based on the social behaviours of birds flocking and fish schooling.

Proposed system has the following blocks listed below

(1) Power GUI

In MATLAB ISE Power GUI block empowers to choose one of the following methods implement circuit.

- Continuous, utilize a variable-step solver tool from Simulink Matlab Simulator.
- Discretization of the electrical system for a solution at fixed time steps
- Phasor solution

The powergui block becomes disabled during model update. To ensure proper model execution, no need to restore the library link for the powergui block. An use multiple powergui blocks in a system that contains two or more independent electrical circuits that you want to simulate with different powergui solvers.

(2) D-STATCOM

D-STATCOM is a shunt connected device designed to regulate the voltage either by generating or absorbing the reactive power. DC Capacitor. A Distribution Static Compensator is in short known as D-STATCOM. It is a power electronic converter based device used to protect the distribution bus from voltage unbalances. It is connected in shunt to the distribution bus generally at the PCC.

- Voltage Source Inverter (VSI)
- Coupling Transformer
- Reactor

(3) Measurements:

Measurement device are used for the measurement and control of various parameters like voltage current and distortions.

(4) PSO Controller :

(PSO) is a population based stochastic optimization technique developed by Dr.Ebehart and Dr. Kennedy in 1995, inspired by social behavior of bird flocking or fish schooling. PSO controller is a PSO algorithm based controller.

(5) Wind (DG) :

A wind DG is a wind firm based distributed generation system

(6) Timers:

Two separate timers Timer 1 and Timer 2 are used for the real time control Strategies.

(7) Three Phase Dynamic Load:

A three phase Dynamic load is connected in a proposed system for test and synthesis purposes.

III. SIMULATION RESULTS

Implementation and proposed work has done on the MATLAB ISE and simulation of the proposed work has done on Powergui Simscape Power Systems Specialized Technology model.

Outcome waveform of the proposed work has given in Figure 3.1 Three Phase Grid Voltage. Figure 3.2 Three Phase Grid Current. Figure 3.3 Three Phase Bus Voltage Before and After Compensation. Figure 3.4 Negative Sequence Voltage Unbalanced Factors(VUFs). Figure 3.5 Zero Sequence Voltage Unbalanced Factors(VUFs)

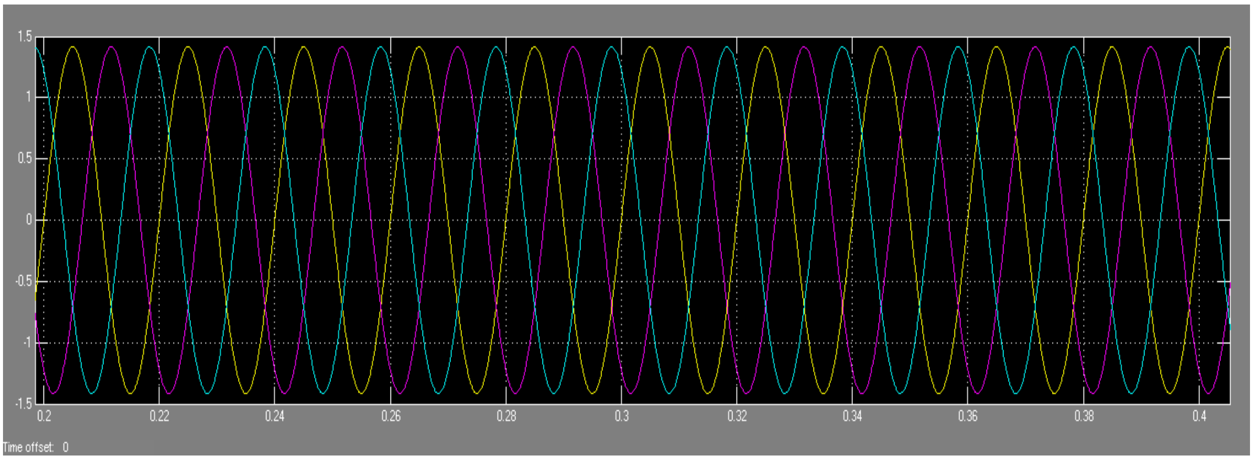

Fig. 3.1 Three Phase Grid Voltage

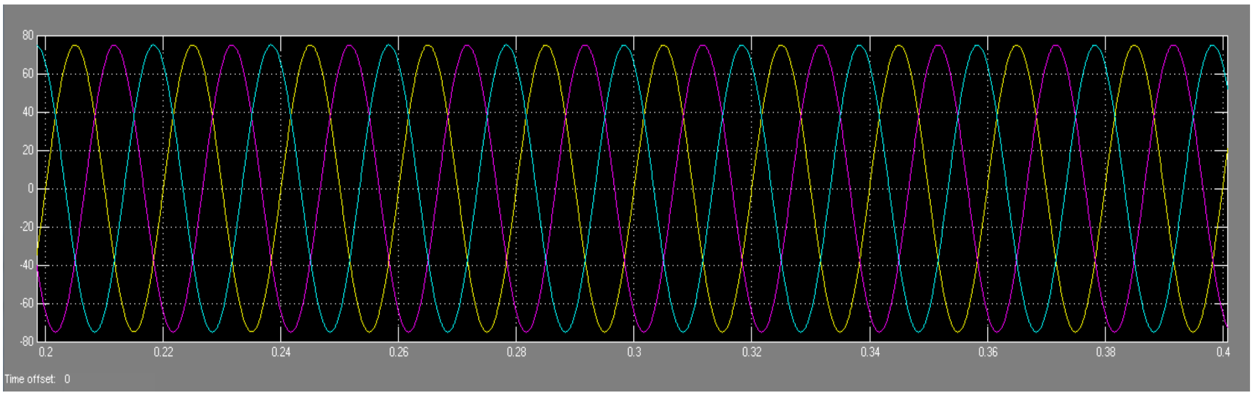

Fig. 3.2 Three Phase Grid Current

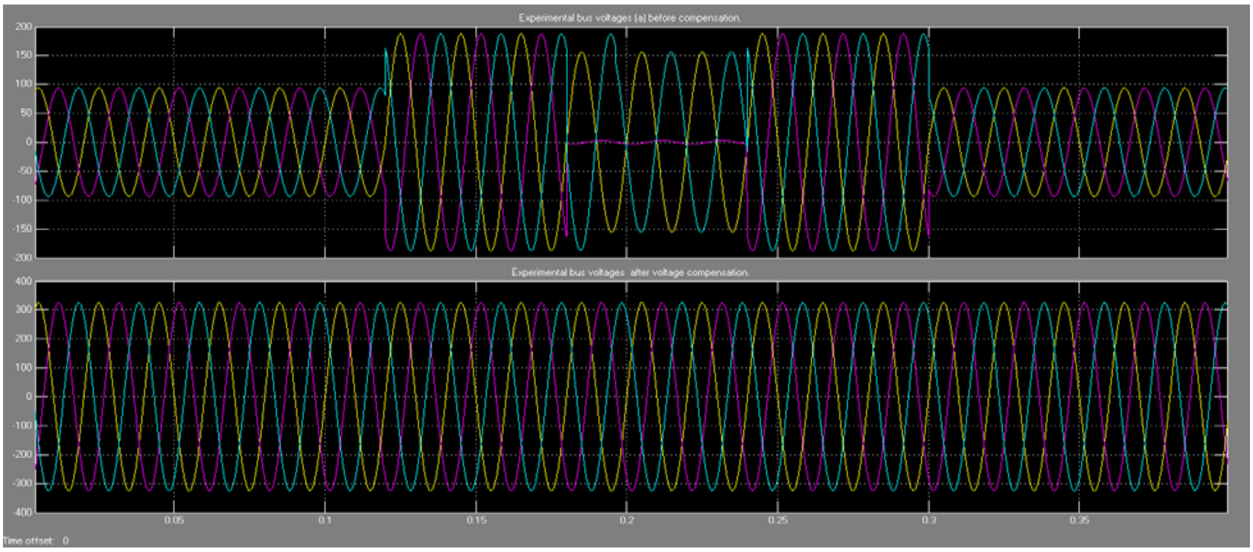

Fig. 3.3 Three Phase Bus Voltage Before and After Compensation

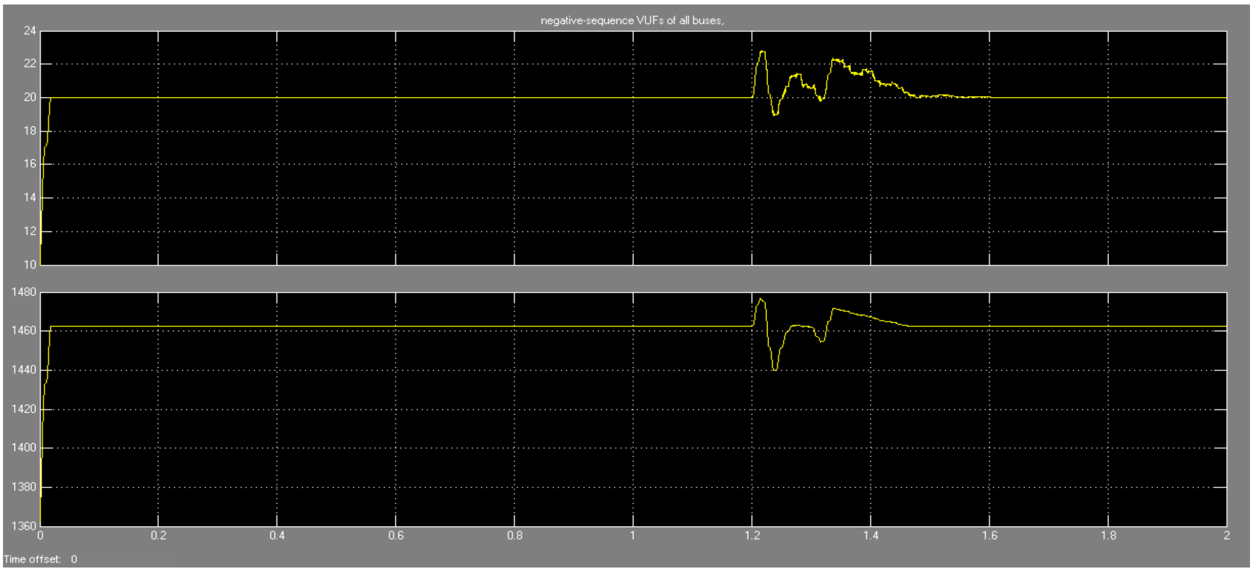

Fig. 3.4 Negative Sequence Voltage Unbalanced Factors(VUFs)

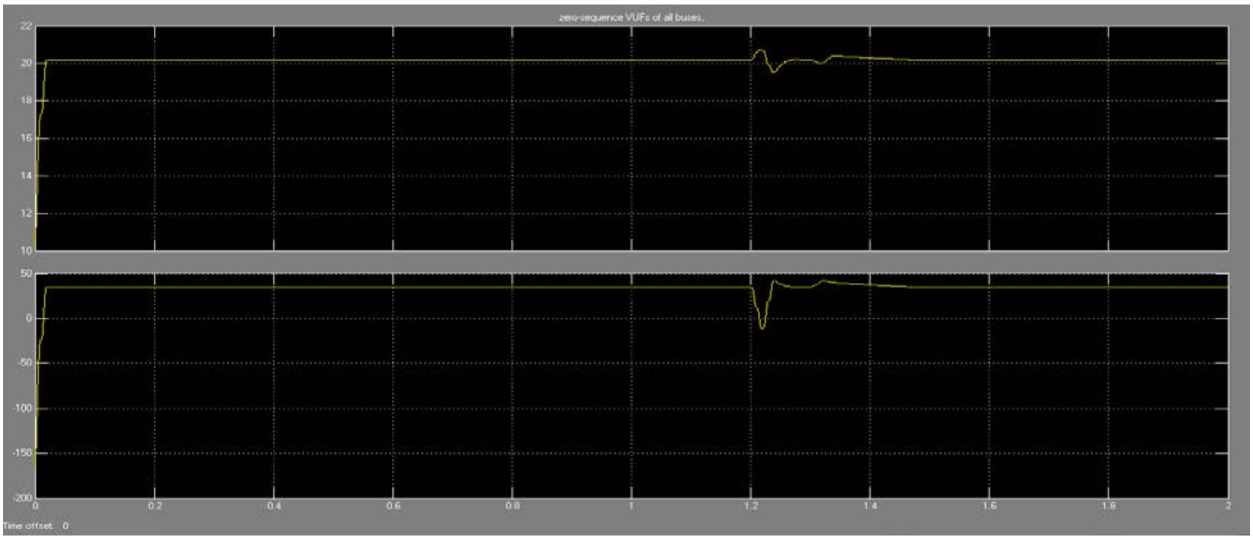

Fig. 3.5 Zero Sequence Voltage Unbalanced Factors(VUFs)

IV. CONCLUSION AND FUTURE SCOPES

The proposed system defined in this work has better balancing capability when hybrid generation system is involved for the delivering the power to the dynamic load. From the simulation result analysis it is clear the voltage balance is better than the previous system. The common current sharing with negative sequence and zero sequence is achieved better. These all are controlled with the DGs and the PSO-DSTATCOM. The proposed system effectively manages the VUFs in the desired threshold to save sensitive loads from getting damaged. In the future extension the controlling schemes can be changed to other soft computing techniques like fuzzy logic and genetic algorithms. The modeling of hybrid microgrid for power system configuration is done in MATLAB/SIMULINK environment. The models are developed for all the converters to maintain stable system under various loads and resource conditions and also the control mechanism are studied. PSO DSTATCOM algorithm is used to harness maximum power from DC sources and to coordinate the power exchange between DC and AC grid.

REFERENCES

[1] X. Zhou, F. Tang, P. C. Loh, X. Jin and W. Cao, "Four-Leg Converters With Improved Common Current Sharing and Selective Voltage-Quality Enhancement for Islanded Microgrids," in IEEE Transactions on Power Delivery, vol. 31, no. 2, pp. 522-531, April 2016.

[2] Gong Hong, Wang Yuhong and Li Yuan, "An improved control strategy of STATCOM for grid voltage unbalance compensation," TENCON 2015 - 2015 IEEE Region 10 Conference, Macao, 2015, pp. 1-4.

[3] A. Mahmoudi and H. R. Karshenas, "Control strategy for voltage unbalance compensation in islanded microgrids," 2015 20th Conference on Electrical Power Distribution Networks Conference (EPDC), Zahedan, 2015, pp. 84-89.

[4] G. C. Konstantopoulos, Q. C. Zhong, B. Ren and M. Krstic, "Bounded droop controller for accurate load sharing among paralleled inverters," 2014 American Control Conference, Portland, OR, 2014, pp. 934-939.

[5] Q. C. Zhong, "Robust Droop Controller for Accurate Proportional Load Sharing Among Inverters Operated in Parallel," in IEEE Transactions on Industrial Electronics, vol. 60, no. 4, pp. 1281-1290, April 2013.

[6] M. Savaghebi, A. Jalilian, J. C. Vasquez and J. M. Guerrero, "Autonomous Voltage Unbalance Compensation in an Islanded Droop-Controlled Microgrid," in IEEE Transactions on Industrial Electronics, vol. 60, no. 4, pp. 1390-1402, April 2013.

[7] H. Farhangi, “The path of the smart grid,” *IEEE Power Energy Mag.,* vol. 8, no. 1, pp. 18-28, Jan./Feb. 2010.

[8] H. Nikkhajoei and R. H. Lasseter, “Distributed generation interface to the CERTS microgrid,” *IEEE Trans. Power Del.,* vol. 24, no. 3, pp. 1598 - 1608, Jul. 2009.

[9] J. Rocabert, A. Luna, F. Blaabjerg, P. Rodriguez, “Control of power converters in ac microgrid,” *IEEE Trans. Power Electron.,* vol. 27, no. 11, pp. 4734-4749, Nov. 2012.

[10] Y. W. Li, D. M. Vilathgamuwa, P. C. Loh, “Microgrid power quality enhancement using a three-phase four-wire grid-interfacingcompensator,” *IEEE Trans. Ind. Appl.,* vol. 41, no. 6, pp. 1707-1719, Nov./Dec. 2005.

[11] F. Wang, J. L. Duarte and M. A. M. Hendrix, “Grid-interfacing converter systems with enhanced voltage quality for microgrid application-concept and implementation,” *IEEE Trans. Power Electron.,* vol. 26, no.12, pp. 3501-3513, Dec. 2011.

[12] C. K. Sao and P. W. Lehn, “Autonomous load sharing of voltage source converters,” *IEEE Trans. Power Del.,* vol. 20, no. 2, pp. 1009-1016, Apr. 2005.

[13] J. M. Guerrero, J. Matas, X. F. de Vicu, L. G. A, M. Castilla, J. Miret, “Wireless-control strategy for parallel operation of distributed- generation inverters,” IEEE Trans. Ind. Electron., vol. 26, no.5, pp. 1461-1470, Oct. 2006.

[14] D. De, V. Ramanarayanan, “Decentralized parallel operation of inverters sharing unbalanced and nonlinear loads,” IEEE Trans. Power Electron., vol. 25, no. 12, pp. 3015-3025, Dec. 2010.