ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

Improvement of Voltage Stability in 57- Bus System Employing Wind Generation using UPQC

K. Vinoath, Dr.Prakash

PG Scholar, Dept. of EEE, Bharath University, Chennai, India

Asst. Professor, Dept. of EEE, Bharath University, Chennai, India

ABSTRACT- This paper deals with Power Quality improvement in 57-bus System employing Wind Generation using Unified Power Quality Conditioner (UPQC). UPQC is a combination of Dynamic Voltage Regulator (DVR) and Active Filter (AF). The 57- bus systems with & without wind generation are modeled and simulated using MATLAB SIMULINK and the results are compared. It is observed that the introduction of UPQC improves the voltage profile and reduces the current harmonics. The UPQC system has advantages like reduced capacitor requirement and improved voltage stability.

KEYWORDS: Active filters Dynamic Voltage Regulator, UPQC, Total Harmonic Distortion, Wind Generator.

I. INTRODUCTION

It is the objective of the electric utility to supply its customers with a sinusoidal voltage of fairly constant magnitude and frequency. The generators that produce the electric power generate a very close approximation to a sinusoidal signal. The planning, design, and operation of industrial and commercial power systems require several studies to assist in the evaluation of the initial and future system performance, system reliability, safety and the ability to grow with production and operating requirements. The conventional AC electric power systems are designed to operate with sinusoidal voltages and currents. However nonlinear loads and electronically switched loads will distort steady state AC voltage and cur-rent waveforms. Periodically distorted waveforms can be stu-died by examining the harmonic components of the wave-forms. Reducing voltage and current waveform distortions to acceptable levels has been a problem in power system design from the early days of alternating current.

However there are loads and devices on the system which have nonlinear characteristics and result in harmonic distortion of both the voltage and current signals. As more nonlinear loads are introduced within a facility, these waveforms get more distorted. In a modern power system due to wide use of nonlinear loads such as adjustable speed drives, electric arc welders, and furnaces it has become necessary to establish criteria for limiting power quality problems. These problems cause reduction in system efficiency, poor power factor, maloperation of electronic equipments and reduction in equipment mean life time. The non linear load injects the harmonic current into the networks and consequently distorts the voltage waveform. This distorted voltage waveform affects other loads connected. To avoid this problem and to protect the loads from distortion, the harmonic components of the voltage and current must be compensated.

By use of Passive filters the problem can be reduces but these have many disadvantages such as fixed compensation, large size, resonance problems. To overcome the above problem, the shunt active filters were used with passive filters [1]-[2], but this method does not reduce the voltage harmonics. In order to deal voltage and current harmonic problems simultaneously, the most sophisticated device i.e., unified power quality conditioner (UPQC) has been developed [2]-[3]. In section 3, a 57-bus system without UPQC and with UPQC modeled and simulated and also comparative analysis of simulation results is presented. Finally, section 4 concludes the results.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

II. UPQC CONFIGURATION

UPQC is a series combination of series and shunt active power filters sharing a common DC link. The two active power filters have different functions. Series filters is operated as a controlled voltage source to suppress and isolate voltage harmonics, same time shunt filters acts as a controlled current source to compensate the current harmonics. This paper presents a complete analysis of UPQC. The basic configuration of the UPQC is presented in figure -1.

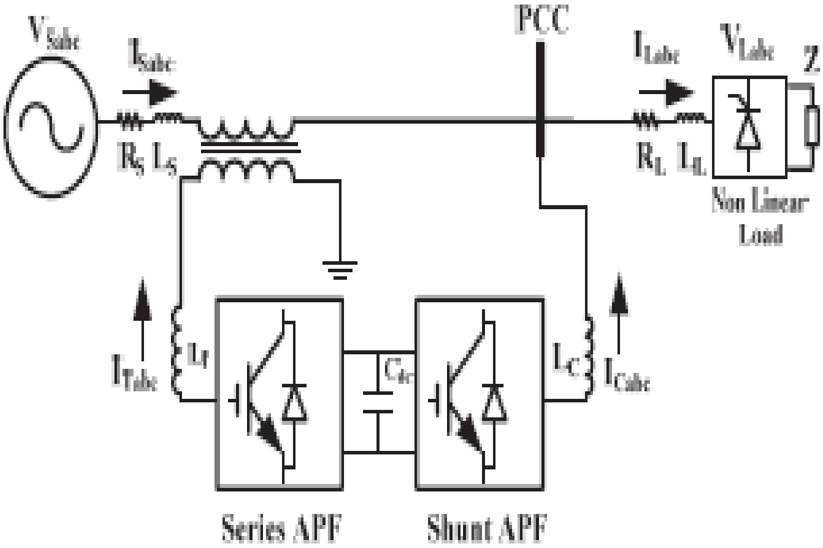

Fig.1: Basic Configuration of UPQC

Fig. 1 shows a basic configuration of general UPQC consisting of two voltage source inverters: one acts as a series APF and the other as shunt APF, which are connected back to back through dc link capacitor. The series APF which is connected between the source and PCC using three single phase series transformers has the capability of compensating the voltage harmonics, voltage flicker and improving voltage regulation [4]. A small rated capacity capacitor filter is connected across the secondary of each series transformers to eliminate the high switching ripple content in the series APF injected voltage [5]. The shunt APF has capability of suppressing the current harmonics, compensating reactive power, negative sequence current and regulation of the dc link voltage between both APF's [4]. The shunt APF is connected through a small rated capacity inductive filter in order to eliminate the high switching ripple content in the shunt APF injected current. Direct control strategy for UPQC IN 3 phase, 4 wire system is given by Yong [5]. Enhancing Electric Power Quality using UPQC is given by Khadkikar [6]. Control scheme for three phase four wire UPQC in a three phase stationary frame is given by Chen [7]. Series active power filter compensates current harmonics and voltage unbalance simultaneously is given by Wallace [8]. UPQC for simultaneous voltage and current compensation is given by Ledwich [9]. Harmonic modeling of residential and commercial loads with unified power quality conditioner is given by Tulasiram [10].

The above literature does not deal with power quality improvement in Wind generation based 57- bus system using UPQC. This work proposes multiple UPQCs for the power quality improvement in multi bus system.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

III. SIMULATION RESULTS

The 57- bus system without wind generation is modeled using the elements of SIMULINK has shown in fig 2.a. Generators are represented as voltage sources. Line is modeled as series combination of R and X. Load is represented as shunt impedance. The bus voltage, real power and reactive power at Bus – 12 are shown in figures 2-b, 2-c & 2-d respectively. The voltage at Bus – 12 decreases suddenly due to addition of heavy load. The Real power and Reactive power also decreases due to reduction of voltage.

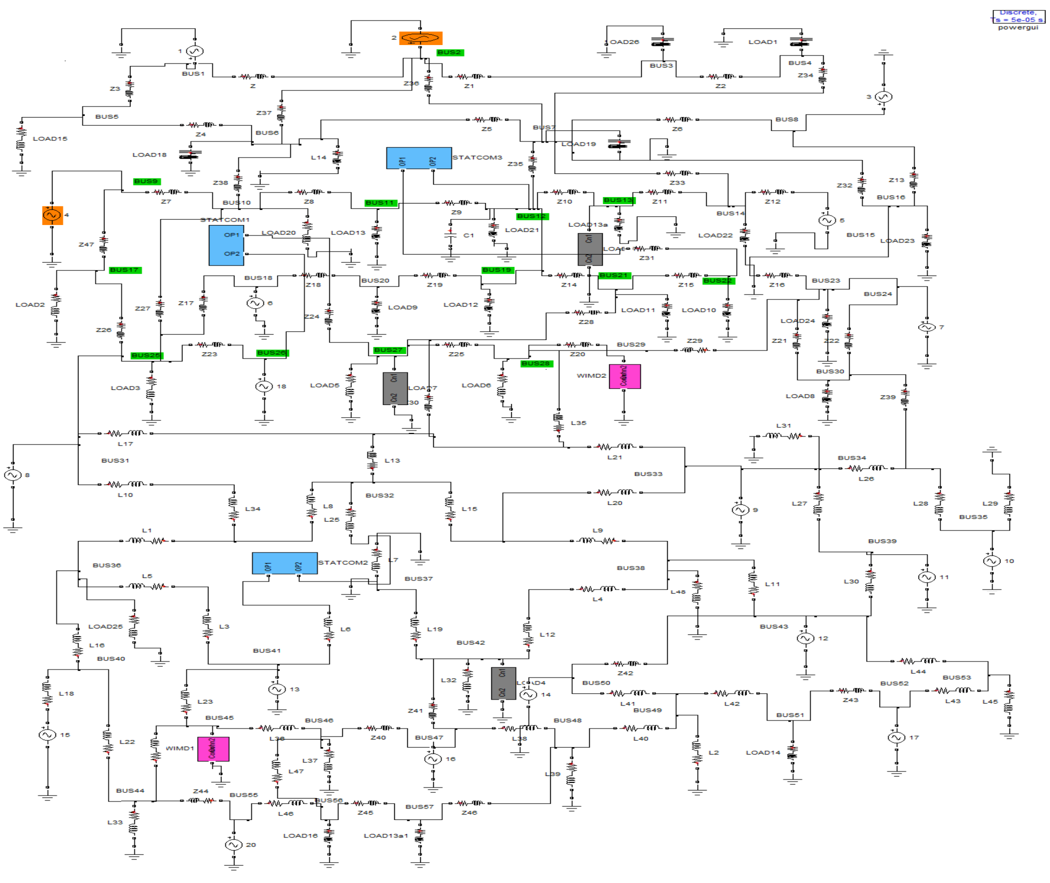

Fig.2.a: 57 Bus Systems without wind generation

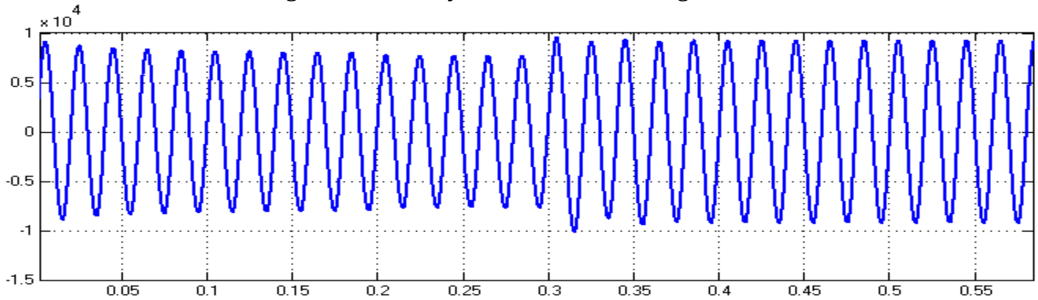

Fig.2.b: Voltage at Bus - 12

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

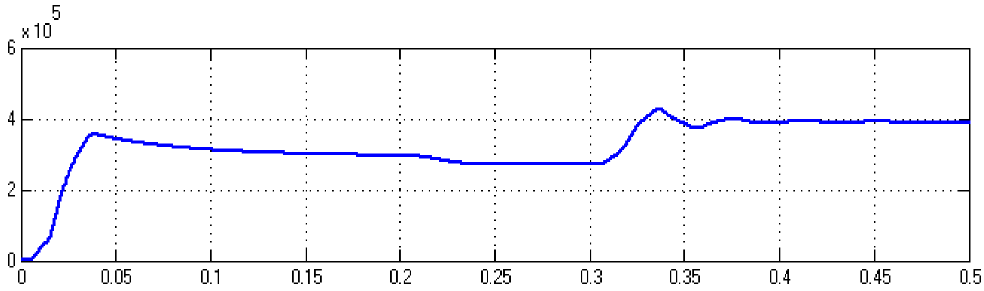

Fig.2.c: Real Power at Bus - 12

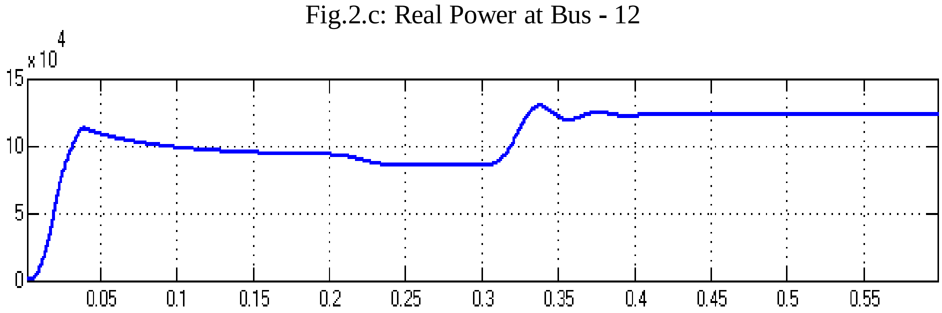

Fig.2.d: Reactive Power at Bus – 12

The Voltage, Real power and Reactive power at Bus – 13 are shown in figure 2-e, 2-f & 2-g respectively. The bus voltage, real power & reactive power at Bus – 13 are shown in figures 2-h, 2-i & 2-j respectively.

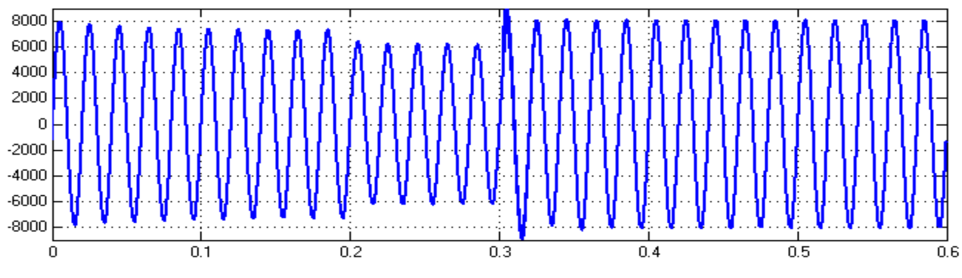

Fig.2.e: Voltage at Bus - 13

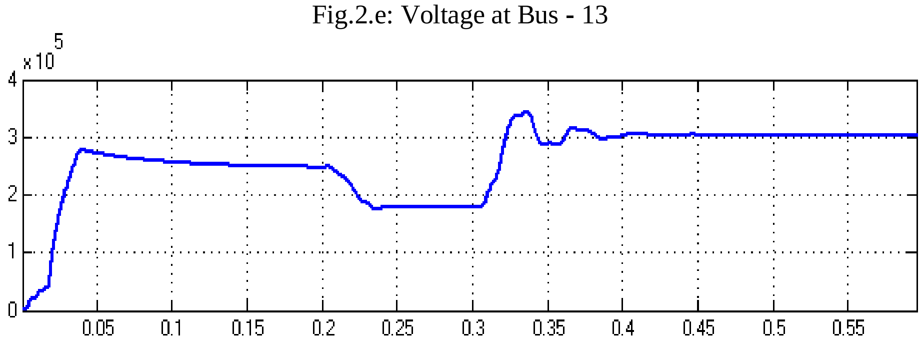

Fig.2.f: Real Power at Bus - 13

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

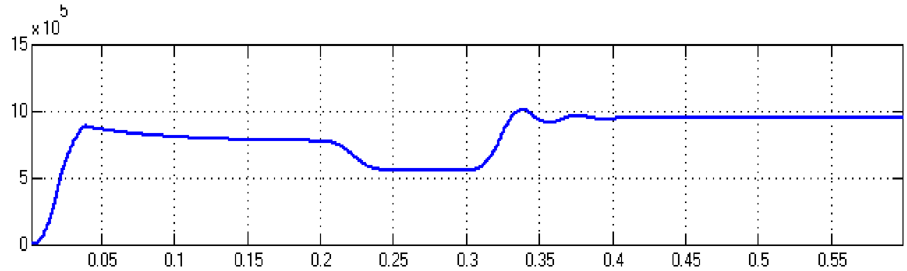

Fig.2.g: Reactive Power at Bus – 13

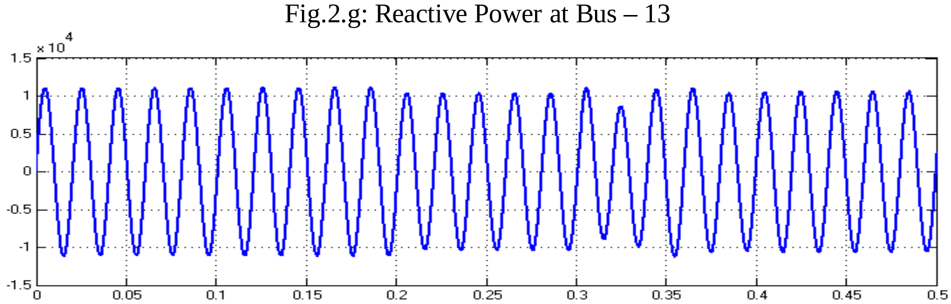

Fig.2.h: Voltage at Bus - 27

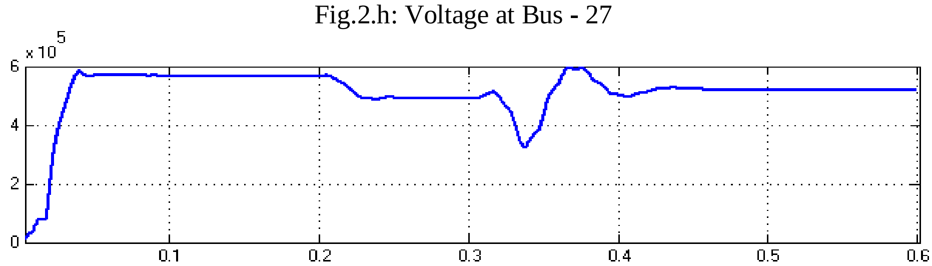

Fig.2.i: Real power at Bus – 27

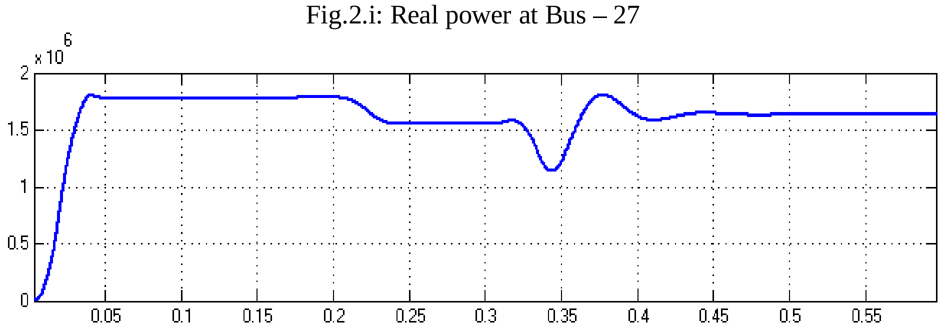

Fig.2.j: Reactive power at Bus – 27

The 57- Bus system with UPQC is shown in fig 3-a. The UPQC's are added to improve the Power Quality. The voltage required by the UPQC is obtained by rectifying the output of a Wind Generator.

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

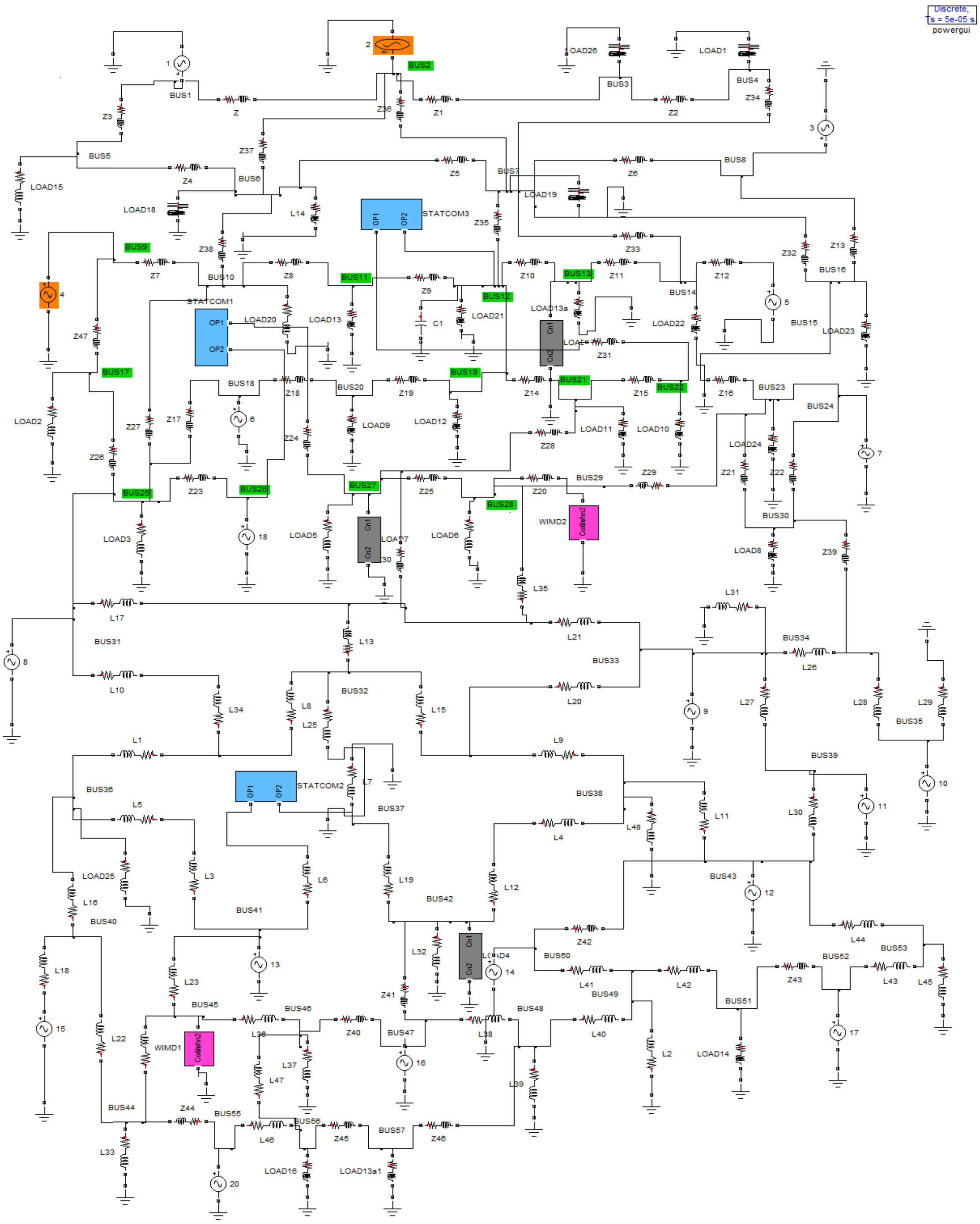

Fig.3.a: 57- Bus Systems with UPQC

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

The output of the Wind Generator is shown in figure 3-b. The circuit model of UPQC is shown in figure 3-c. The inverter on right side is used for the Active Filter and Inverter on left side is used for DVR.

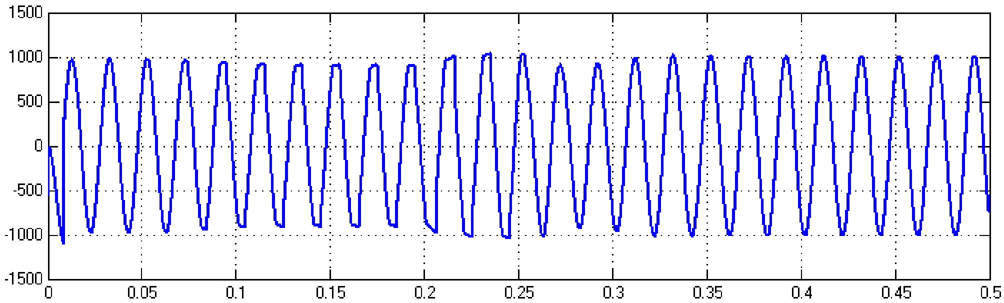

Fig.3.b: Output Voltage of Generator

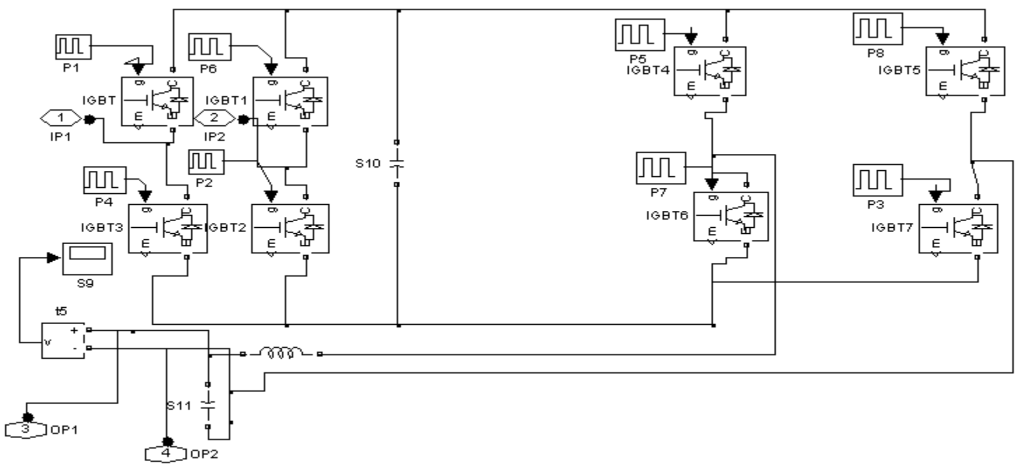

Fig.3.c: Model of UPQC

The Bus voltage, Real power and Reactive power at Bus – 12 with UPQC are shown in figures 3-d, 3-e & 3-f respectively. It can be seen that the voltage reseems to the normal value due to the addition of UPQC.

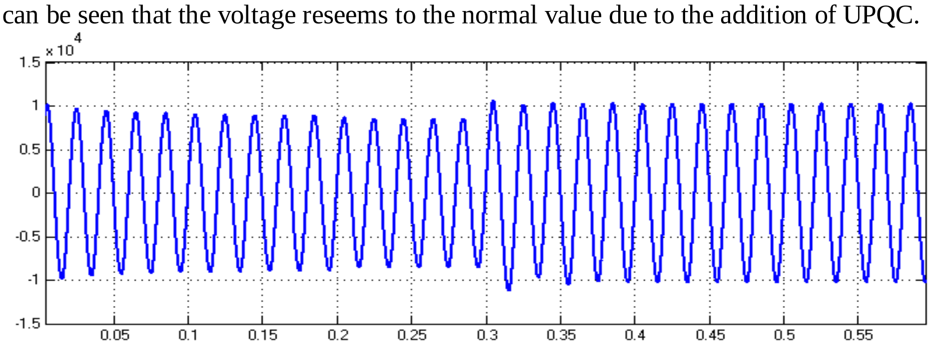

Fig.3.d: Voltage at Bus - 12

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

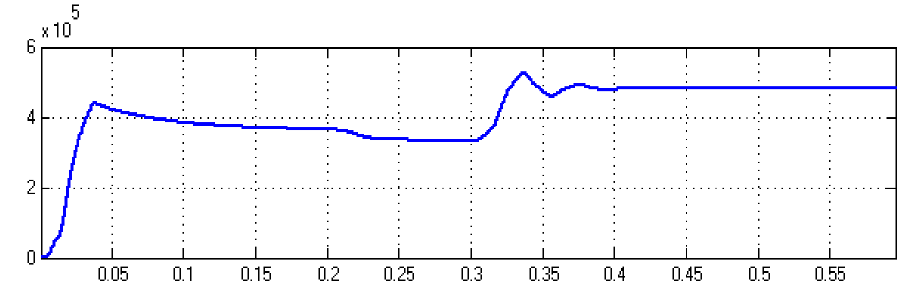

Fig.3.e: Real Power at Bus - 12

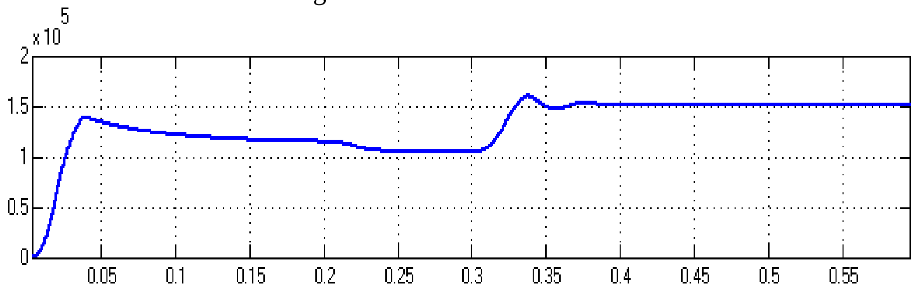

Fig.3.f: Reactive Power at Bus – 12

The bus voltage, real power and reactive power at Bus-13 are shown in figures 3-g, 3-h & 3- i respectively.

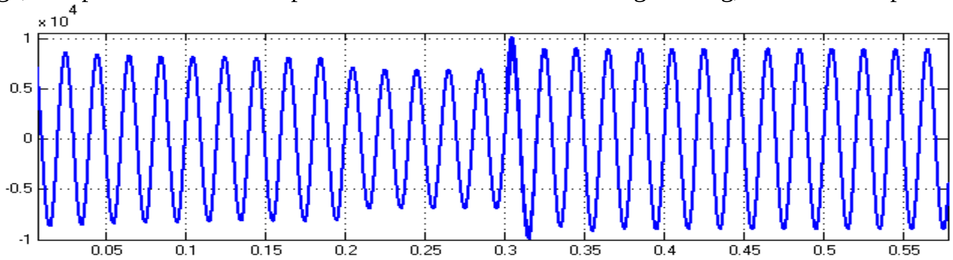

Fig.3.g: Voltage at Bus - 13

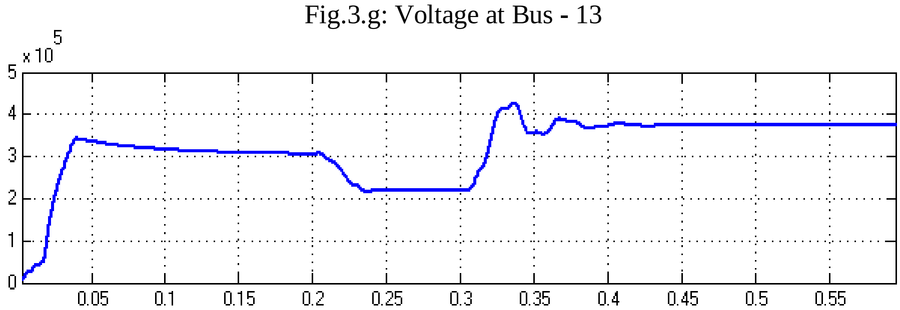

Fig.3.h: Real Power at Bus - 13

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

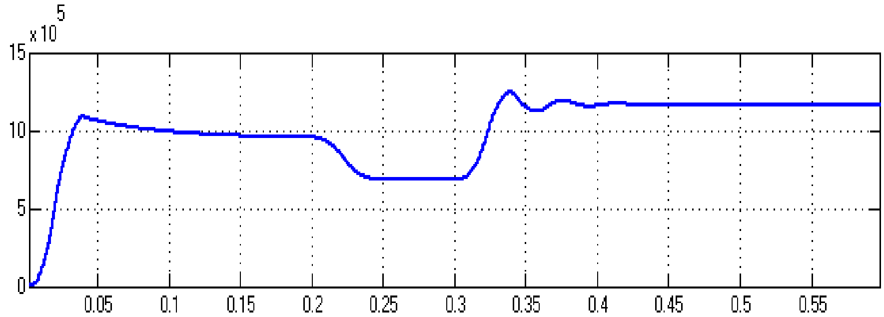

Fig.3.i: Reactive Power at Bus - 13

The bus voltage, real power & reactive power at Bus – 27 are shown in figures 3-j, 3-k, 3-l respectively. It is observed that the voltage stability improved in the buses nearer to the UPQC.

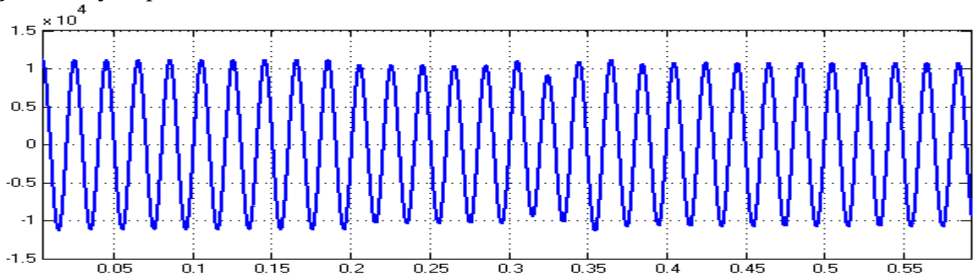

Fig.3.j: Voltage at Bus – 27

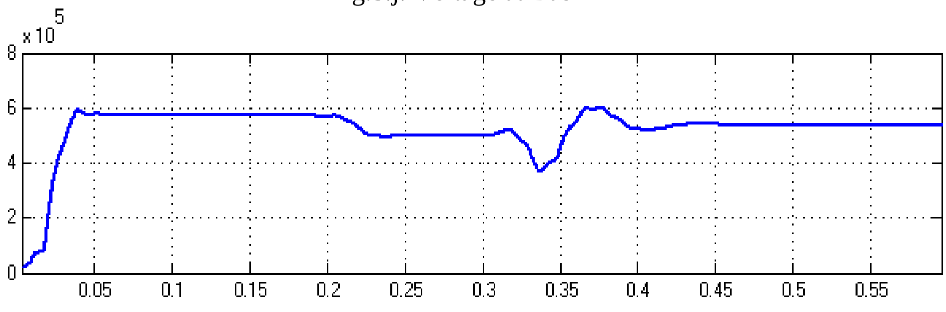

Fig.3.k: Real Power at Bus - 27

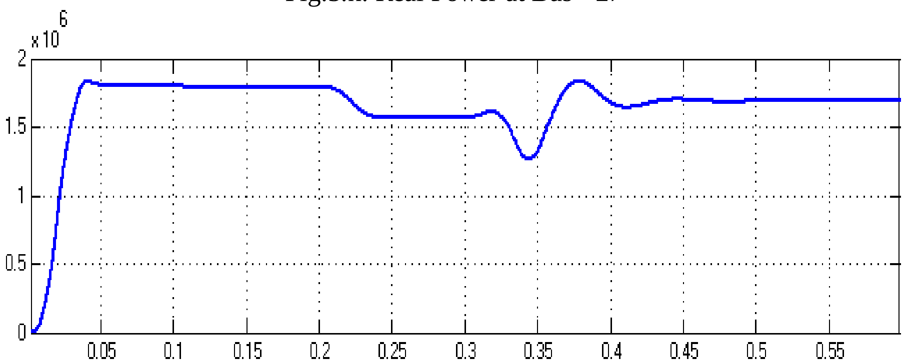

Fig.3.l: Reactive Power at Bus – 27

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

Table -1
Comparison of with and without wind generation of 57-bus output voltages

Bus no	Without wind(Kv)	With Wind(Kv)
3	9.40	9.45
4	8.80	8.87
5	11.30	11.38
6	10.20	10.56
7	9.80	9.90
10	11.10	11.78
12	9.10	10.45
13	8.02	9.45
14	11.20	11.35
16	11.14	11.68
17	11.98	12.20
19	10.20	10.58
20	11.13	11.78
21	9.51	10.53
22	9.81	11.56
24	12.15	12.48
25	12.30	12.63
27	10.00	11.02
28	10.23	11.63
30	12.05	12.56
32	7.50	8.32
34	12.56	12.63
36	11.10	11.78
37	7.90	8.12
38	7.99	8.23
42	9.51	10.42
44	10.05	10.25
46	7.40	7.96
48	6.58	7.86
49	6.75	6.89
51	6.12	7.69
53	6.86	7.83
56	9.51	10.25
57	7.08	9.87

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

Table -2
Comparison of with and without wind generation of 57-bus Real & Reactive powers

Bus no	P (MW) without Facts	P (MW) with Facts	Q (MVAR) without Facts	Q (MVAR) With Facts
3	0.430	0.436	1.352	1.357
4	0.366	0.367	1.150	1.158
5	0.272	0.276	0.128	0.129
6	0.473	0.476	1.488	1.499
7	0.526	0.529	1.653	1.670
10	0.551	0.563	1.730	1.742
11	0.564	0.569	1.738	1.749
12	0.390	0.481	0.122	0.152
13	0.302	0.373	0.952	1.173
14	0.325	0.327	1.022	1.051
16	0.413	0.425	1.301	1.309
17	1.413	1.414	0.805	0.809
19	0.382	0.386	0.150	0.155
20	0.477	0.478	0.189	0.192
21	0.534	0.0.542	1.679	1.681
22	1.588	1.589	0.598	0.601
24	0.534	0.536	2.513	2.620
25	0.801	0.809	1.670	1.679
27	0.519	0.523	1.633	1.670
28	0.483	0.488	1.519	1.520
30	0.469	0.496	1.472	1.479
32	0.479	0.454	0.501	0.510
34	0.231	0.240	0.145	0.149
36	0.529	0.580	1.660	1.670
37	0.431	0.445	0.451	0.468
38	0.508	0.515	0.532	0.541
42	0.873	0.880	0.915	0.921
44	0.440	0.449	0.461	0.472
46	0.348	0.351	0.364	0.372
48	0.372	0.380	0.351	0.365
49	0.119	0.128	0.374	0.389
51	0.386	0.397	0.465	0.486
53	0.329	0.330	1.196	1.216
54	0.508	0.513	0.532	0.558
56	0.339	0.348	0.118	0.123
57	0.234	0.245	0.734	0.748

ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(A High Impact Factor, Monthly, Peer Reviewed Journal)

Website: www.ijareeie.com

Vol. 6, Issue 10, October 2017

IV. CONCLUSIONS

Wind Generator based UPQC in 57- Bus system is successfully designed, modeled & simulated using MATLAB SIMULINK. The comparison of results of 57- Bus system with & without multiple wind generation UPQC's indicating that the voltage stability is largely improved by the addition of multiple UPQC's. The merits of UPQC are sag mitigation, reduction of heat in the Alternator & improvement of voltage at load buses. The disadvantage of UPQC is that it requires DC source to charge the DC link Capacitor & the firing circuits are to be designed to operate at different frequencies.

The scope of present work is the modeling & simulation of 57- Bus system with UPQC. The investigations 57-bus closed loop will be carried in future.

REFERENCES

[1] H. Akagi, "New trends in active filters for power conditioning," IEEE Trans. Ind. Applicat., vol. 32, pp. 1312-1332, Nov/Dec. 1996.

[2] H. Akagi, E. H. Watanabe, and M. Aredes, "Instantaneous power theory and applications to power conditioning," Hoboken, NJ: Wiley IEEE Press, Apr. 2007.

[3] H. Fujita and H. Akagi, "The unified power quality conditioner: The integration of series and shunt active filters," IEEE Trans. Power Electron., vol. 13, no. 2, pp. 315-322, Mar. 1998.

[4] Teke, L. Saribulut and M. Tumay, " A novel reference signal generation method for power quality improvement of unified power quality conditioner," IEEE Trans. Power Del., Vol. 26, no. 4, pp. 2205-2214, Oct. 2011.

[5] Tan Zhili, Li Xun, Chen Jian, Kang Yong and Duan Shanxu, " A direct control strategy for UPQC in three-phase four-wire system," Proc. IEEE Conf. on Power Electronics and Motion Control 2006, vol. 2, pp. 1-5.

[6] V. Khadkikar, "Enhancing Electric Power Quality Using UPQC: A comprehensive overview," IEEE Trans, Power Electron. Vol. 27, No. 5. Pp. 2284 – 2297, May 2012.

[7] Li. Xun, Zhu. Guorong, Duan Shanxuand Chen Jian Chen, "Control scheme for three-phase four wire UPQC in a three-phase stationary frame," Procd. IEEE/IECON 2007, pp. 1732-1736, 2007.

[8] L. Moran, I. Pastonini, J. Dixon and R. Wallace, "Series active power filter compensates current harmonics and voltage unbalance simultaneously," Proc. IEE Gener., Trans. and Distrb., Vol. 147, No.1, pp. 31-36, Jan 2000.

[9] A. Ghosh and G. Ledwich, "A unified power quality conditioner (UPQC) for simultaneous voltage and current compensation," Elect. Power Syst. Res., pp. 55-63, 2001.

[10] R. Kameswara Rao and S.S. Tulasiram, "Harmonic modeling of residential and commercial loads with unified power quality conditioner," International journal of scientific & engineering research, vol. 3, issue 6, June-2012 1, ISSN 2229-5518.

BIOGRAPHY

G.V. Prasanna Anjaneyulu has completed his B.E in 2005 from Andhra University and M.Tech in 2009 from NIT Calicut. He has a teaching experience of nine years. Presently, he is a Research Scholar at S.V. University college of Engineering. His research area is on Power Quality improvement in multibus system.

Dr. P. Sangameswara raju has completed his B.E , M.Tech & Ph.D from S.V.University college of Engineering. He has 30 years teaching experience. Currently he working has Professor in EEE department S.V.University college of Engineering. His areas of interests are Power System Operation & Control, Renewable Sources of Energy.