POWER QUALITY ENHANCEMENT OF A SYNCHRONOUS GENERATOR BASED DIESEL-PV HYBRID MICROGRID SYSTEMUSING ADAPTIVE FILTER CONTROL SCHEME

[1]T.Venkata Prasad,[2]M.Sreedevi,[3]V.Naveen Krishna
[1]Assistant Professor,[2,3]UG Scholar,Dept. Of E.E.E
[1,2,3]Sree Venkateswara College Of Engineering, North Rajupalem, Nellore ,A.P

Abstract— This paper shows an isolated microgrid, with synchronous generator(SG) based diesel generation(DG) framework in mix with solar based photovoltaic(PV). The DG supplies capacity to the heap legitimately, and a battery upheld voltage source converter (VSC) is associated in shunt at point of common coupling (PCC). The PV exhibit is associated at DC-connection of the VSC through a lift converter. A high request improvement based adaptive filter control scheme is utilized for keeping up the nature of PCC voltages and source flows. This controller makes the waveform free of mutilation, expels blunders because of unbalances, remedies the power factor and makes the source current smooth sinusoidal, regardless of the idea of burden. MATLAB/Simulink based reenactment results show attractive execution of the given framework.

I.INTRODUCTION:

Renewable energy (RE) is being gazed upon as the ultimate panacea for tackling global warming, changing climate and controlling the continued depletion of fossil fuels. Hence, researchers, government sectors and utilities altogether are trying to integrate RE systems into the power grid and distribution networks . In the current scenario, the solar energy is the best form of RE in terms of its clean nature, noise-less, non-polluting and available in abundance even in remote locations. Some of the major potential challenges to be faced when integrating solar photovoltaic (SPV) system with the grid are voltage instability, reliability, weak grid system and degraded power quality . The SPV system has proved to be a cutting edge technology in the field of power system as it has been very effective in supplying power at remote locations where transmission networks can't reach, as it is easy to install, requires low maintenance and has various other advantages. In a conventional double stage topology, first stage involves maximum power point tracking and the second stage controls the extracted power into the distribution network.

Burning of fossil fuels for producing electricity has been a major cause of global warming . Thus, researchers have been looking for alternative sources for electricity production, which are sustainable and environment friendly . Moreover, countries are working towards making their whole automobile fleet and electricity production sectors free of burning fossil fuels . This has led to rise in renewable based energy systems such as PV, wind, hydro, biomass, ocean thermal energy, tidal energy, etc. Lately, renewable energy based microgrids are becoming increasingly popular to supply power to urban, rural or remote areas. Such systems can be operated with or without grid . These sources are imperishable and cause no harm to the environment, however, their variable and fluctuating nature makes the task of integrating them a real challenge . This gives rise to the need of intelligent controllers which can regulate the voltage, current and frequency of the system in case of presence/absence of grid or linear/nonlinear load or unbalance in the three-phase systems, and hence, make the system more stable, reliable and secure.

II.LITERATURE REVIEW:

Diesel engines can be used with permanent magnet synchronous generators, induction generators or synchronous reluctance generators, etc.. The best fuel efficiency is obtained in diesel generators when they are operated at 80% to 100% of their rated capacity 8. Diesel generators have been source of electricity for long. In urban areas, they are used as a back-up where as in rural areas, it is one of the primary sources of electricity. Thus, the PV based microgrids could be made more stable and reliable by integrating them with diesel generators. Many authors have worked on such systems and proposed controllers for regulating voltage, current and power flow, 0. However, use of energy storage devices along with PV-DG not only helps in reducing rating of DG, it also efficiently takes care of the transients and maintains the DC-link voltage. Many researchers have proposed power quality controllers for micro-grids. Least mean square (LMS) is an old technique of removing noise and distortions from the signal. Based on LMS, algorithms such as hyperbolic tangent function based LMS, modified variable step filtered-x LMS (FXLMS) based control, etc. have been presented in order to achieve load leveling, voltage and frequency control and power quality enhancement. LMF is a higher order filter as compared to LMS, and thus, it has a higher signal to noise ratio (SNR) 4. The superiority of this control over conventional LMS algorithms, in terms of mean square error (MSE) and stability, has been presented.This paper demonstrates an adaptive filter, in a three-phase DG-PV based isolated micro-grid. It removes the harmonics present in the current due to the nonlinear loads, and makes it smooth sinusoidal, thus, reducing the total harmonic distortion (THD) as per IEEE-519 standard. A boost converter connects PV and DC-link of VSC, and executes the maximum power point tracking (MPPT) for PV array. The battery is directly connected at the DC-link.

Many researchers have proposed power quality controllers for micro-grids. Least mean square (LMS) is an old technique of removing noise and distortions from the signal. Based on LMS, algorithms such as hyperbolic tangent function based LMS [12], modified variable step filtered-x LMS (FXLMS) based control [13], etc. have been presented in order to achieve load leveling, voltage and frequency control and power quality enhancement. LMF is a higher order filter as compared to LMS, and thus, it has a higher signal to noise ratio (SNR) [14]. The superiority of this control over conventional LMS algorithms, in terms of mean square error (MSE) and stability, has been presented in [15] and [16].

III.EXISTING SYSTEM:

Existing technique proposed the utilization of a least mean fourth (LMF) based algorithm for single-organize three-stage lattice incorporated SPV (Solar Photovoltaic) framework. It comprises of SPV exhibit, VSC (Voltage Source Converter), three-stage lattice and direct/nonlinear loads. This framework has a SPV cluster combined with a VSC to give three-stage dynamic power and furthermore goes about as a static compensator for the responsive power pay. It likewise adjusts to an IEEE-519 standard on harmonics by improving the nature of power in the three-stage dispersion arrange. Along these lines, this framework serves to give harmonics lightening, load balancing, power factor correction (PFC) and directing the terminal voltage at the PCC (Point of Common Coupling). So as to build the proficiency and greatest power to be separated from the SPV exhibit at different natural conditions, a solitary stage framework is utilized alongside P&O (Perturb and Observe) strategy for MPPT (Maximum Power Point Tracking) incorporated with the LMF based control procedure

Adaptive filter hypothesis has shown its potential in following changes in the earth and qualities of the obscure frameworks wherein this filter is utilized. With evolving condition, the filter parameters are self-balanced that the conduct of the arrangement of the filter and condition are maintained in control to fill its need. The LMF technique is one of the algorithms from the group of the adaptive filters. LMF has been first proposed by Wallach and Widrow in 1984 as a change to the LMS (Least Mean Square) algorithm . The LMF technique has fundamentally lesser clamor in the loads than the ordinary LMS algorithm when the time consistent qualities for both the strategies are set to be equivalent. The principle objective of this algorithm is to give a decreased unfaltering condition of maladjustment for the accepted rate of learning when contrasted with the LMS procedure. It has been seen that the LMS procedure can't accomplish great consistent state execution in situations having low SNR's (Signal to Noise Ratios) as it works like a lower request adaptive filter. To conquer this issue and to improve the consistent state execution of the framework, a fourth-request power advancement has been connected which can kill clamor obstructions even in low SNR areas 8. Thus, the LMF strategy goes about as a higher request adaptive filter wherein the refreshing condition includes fourthorder power advancement. It has been seen that adaptive algorithms like LMF with high request snapshots of errors perform better MSE (Mean Square Error) than customary LMS algorithms which has been demonstrated . MSE is a parameter which gives a thought regarding the exhibition of error required with the algorithm

IV.PROPOSED SYSTEM:

A. SYSTEM DESIGN AND MODELING

Fig. 1 depicts the configuration of the system. A two stage PV system is supplying power to the nonlinear load, through a VSC. The battery is connected directly at the DC-link. An SG based DG is connected at PCC to provide support power in case of low or absence of insolation.

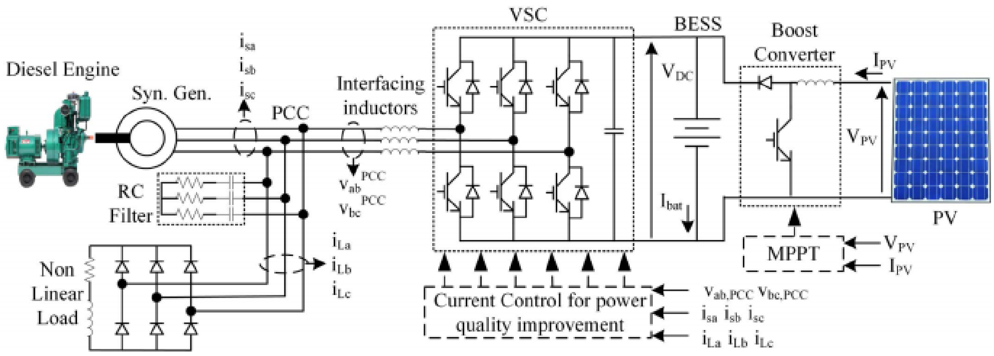


Fig. 1 System model

B. VSC CONTROL

The adaptive control for regulating power quality at PCC through VSC is shown in Fig. 2. It calculates the weight of the active and reactive components of currents and estimates the reference current for each phase, using the in-phase and quadrature unit templates of voltage.

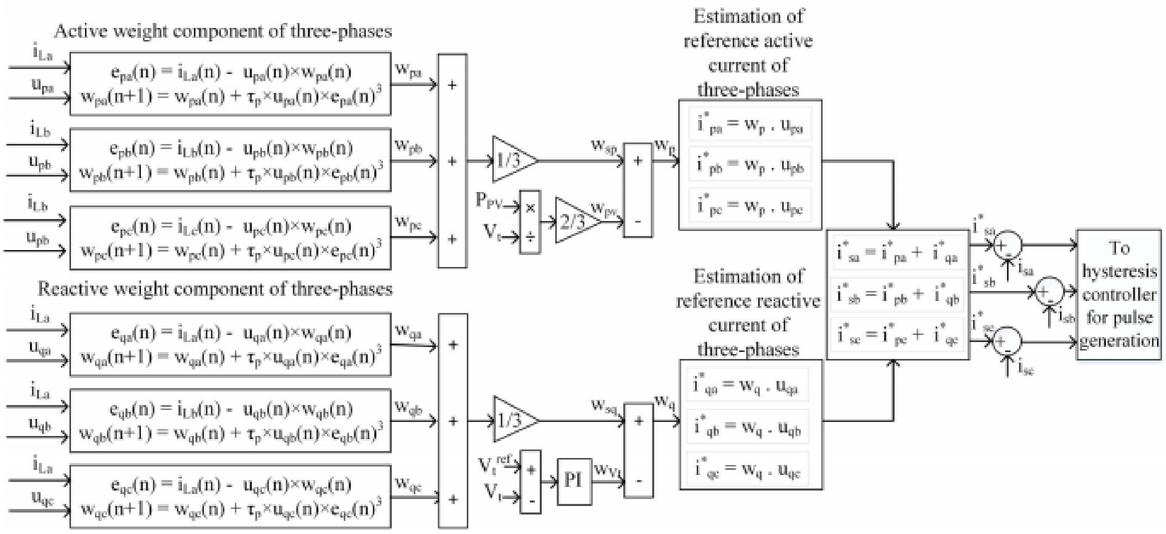


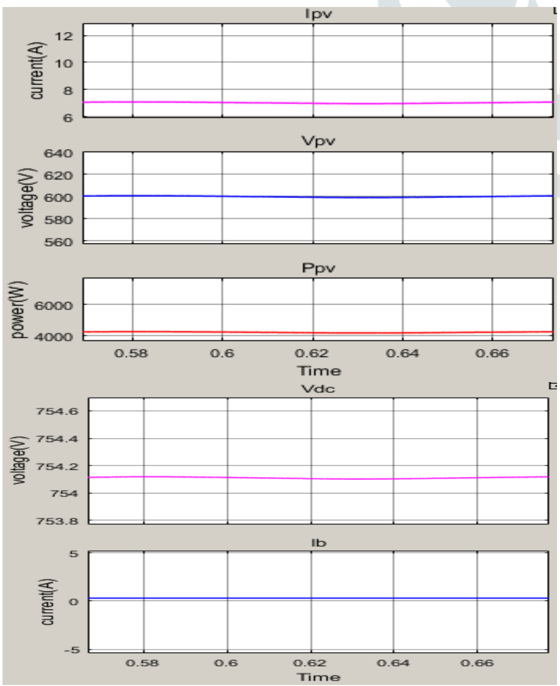
Fig. 2 Adaptive filter for power quality improvement

V. SIMULATION RESULTS

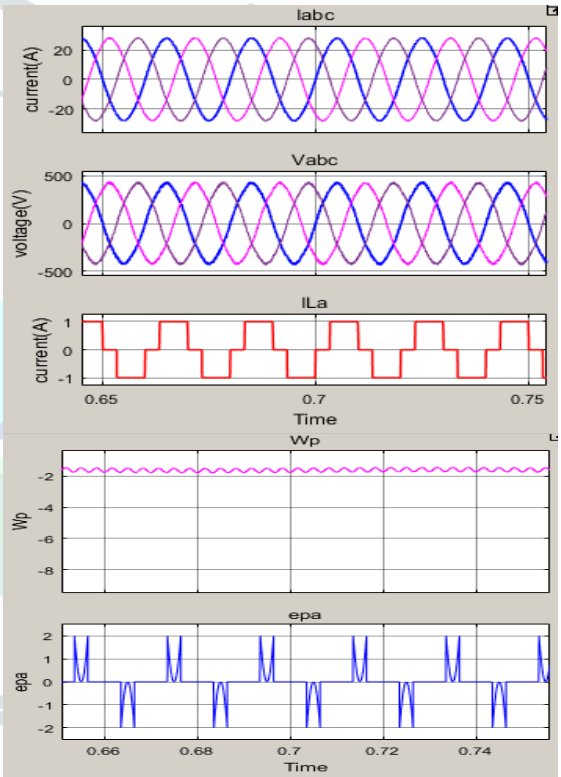
The proposed micro-grid is simulated in MATLAB/Simulink and the responses for change in load, load unbalance and PV variation are observed.

A. Steady State Operation

The steady state response where the load is constant, and is supplied power by both DG and PV, is shown in Fig. 3. The DC side parameters i.e. PV voltage, current and power, DC-link voltage and battery current can be seen in Fig. 3(a). It can be noted that PV is operating in MPPT at solar insolation of 500W/m2. The load and DG side voltage and currents are shown in Fig. 3(b). The internal parameters of the control wp and epa are also shown in the same figure. The THD in currents and voltage are presented in Table I.



(a)



(b)

Fig. 3 Steady State Response of DG-PV micro-grid.

TABLE I

TOTAL HARMONIC DISTORTIONS

Parameter	Signal	THD
Load Current	iLa	26.69%
DG Current	isa	2.05%
PCC Voltage	vsab	3.67%

B. Effect of PV variation

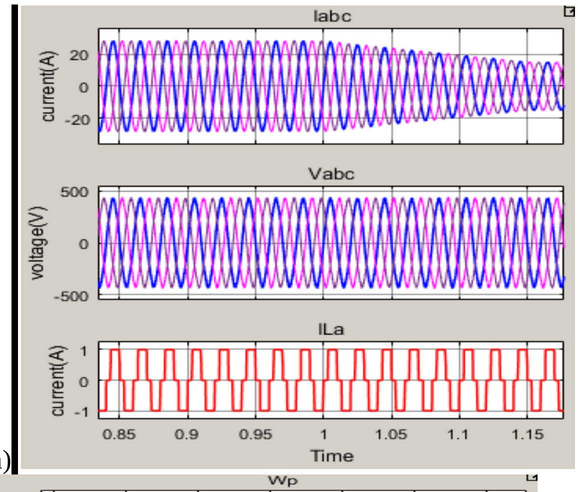
The response of system to PV insolation change is depicted in Figs. 4(a) and (b). At t = 1s, insolation rises from 500W/m2 to 1000W/m2, raising the PV power from 4.2kW to 8.4kW approximately, as seen in Fig. 4(a). Since the load current is constant, this leads to decrease in the net active weight of the DG current, thus, reducing the current drawn from DG. The same is depicted in Fig. 4(b). The DC-link and AC voltages are maintained constant by battery and VSC

C. Effect of Demand Variation

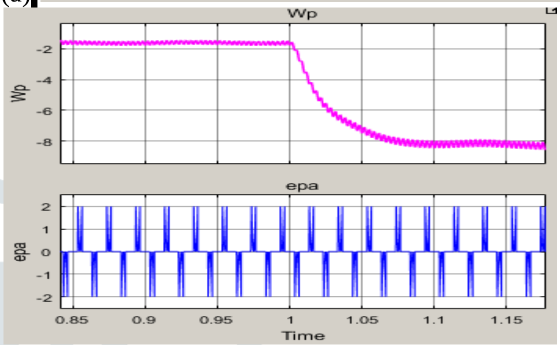
The effect of change in load is demonstrated in Figs. 4(c) and (d). The DC side voltage current and power remain same, as their is no change in the solar insolation. It can be observed from Fig. 4(d), that the reduction in load simply lowers down the current drawn from DG, as the active weight component has been decreased by the VSC controller. The quality of current and voltage are regulated all the time.

D. Effect of Unbalance

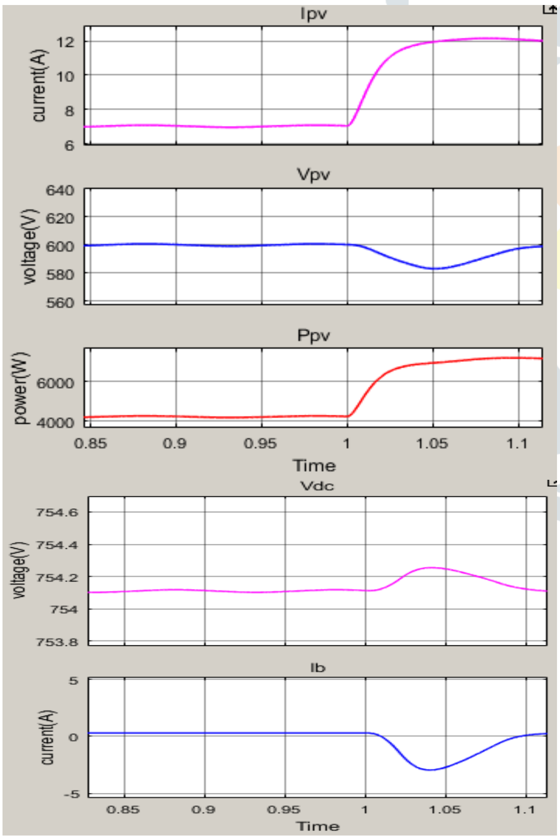
A single-phase open circuit fault is created in phase-a. The response of system is shown in Figs. 4(e) and (f). As net load has reduced, the source current of each phase is reduced, but it is still maintained balanced and pure sinusoidal by the controller. The system smoothly recovers and quickly reaches normal steady state, with normal DC and AC voltages.

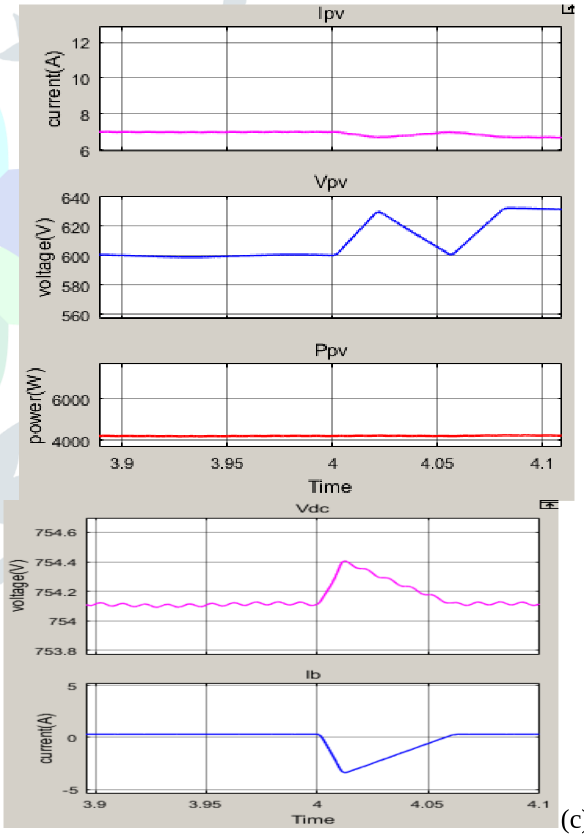


(a)

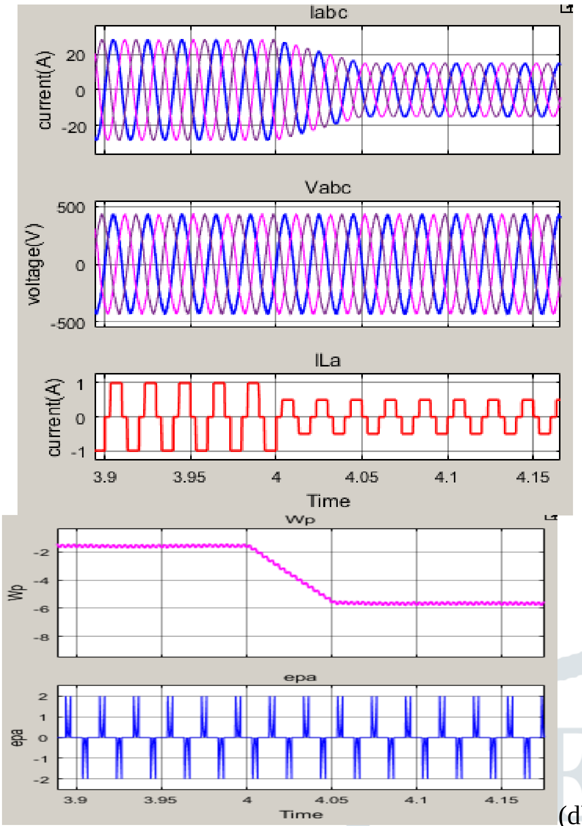


(b)

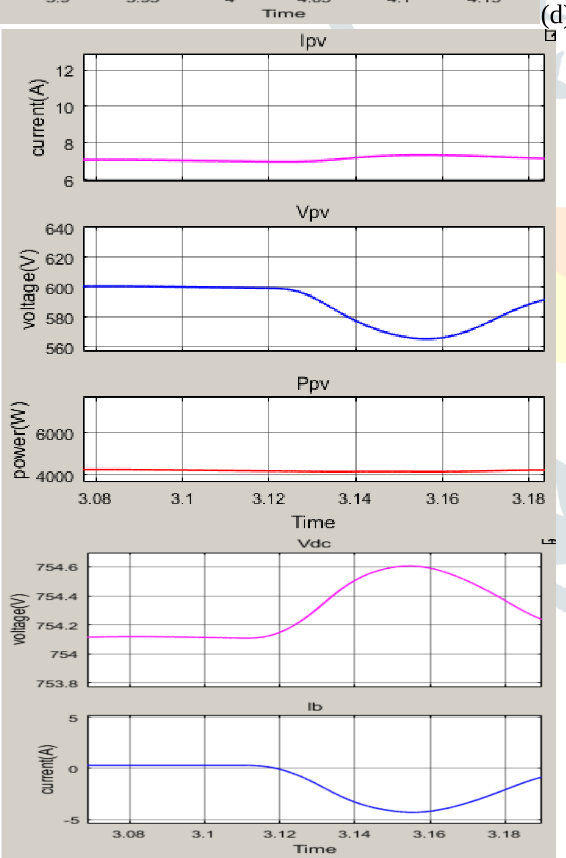




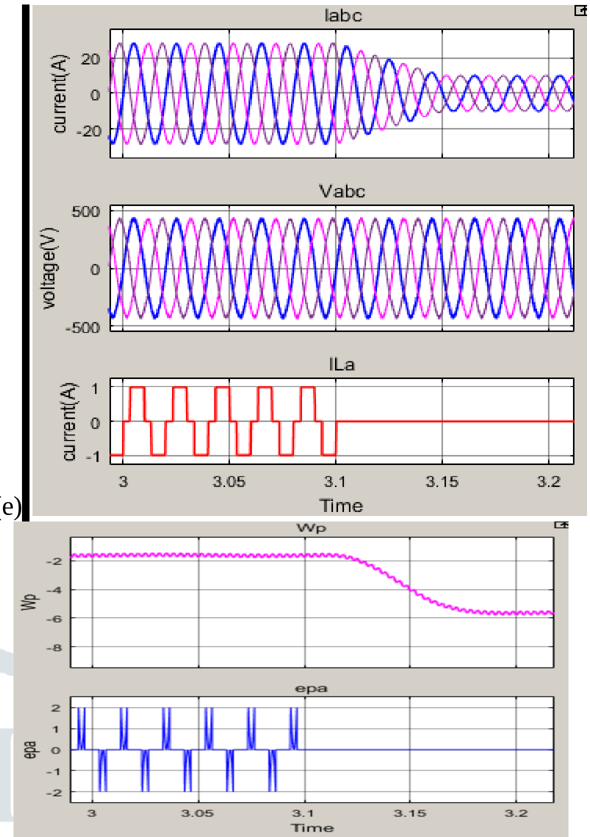
(c)



(d)



(e)



(f)

Fig. 4 Dynamic Response of DG-PV micro-grid

VI. CONCLUSION

An isolated SG based DG and PV hybrid micro-grid has been presented here, with a battery suppported VSC connected at PCC. Three-phase adaptive control is used for power quality improvement through VSC. The given system and control have been simulated in MATLAB/Simulink environment and results demonstrate their satisfactory performance in both steady state and dynamic conditions.

REFERENCES

1. G. Shafiullah et al., “Meeting energy demand and global warming by integrating renewable energy into the grid,” in 22nd Australasian Universities Power Engg. Conf. (AUPEC), pp. 1–7, Bali, 2012.

2. M. Milligan et al., “Alternatives No More: Wind and Solar Power Are Mainstays of a Clean, Reliable, Affordable Grid,” IEEE Power & Energy Mag., vol. 13, no. 6, pp. 78–87, Nov.-Dec. 2015.

3. L. Partain and L. Fraas, “Displacing California’s coal and nuclear generation with

solar PV and wind by 2022 using vehicle-to-grid energy storage," IEEE Photovoltaic Specialist Conf., pp. 1–6, LA, 2015.

4. Daniel E. Olivares et al., "Trends in Microgrid Control," in 2015 IEEE Trans. Smart Grid, vol. 5, no.4, pp. 1905–1919, July, 2014.

5. Z. Zavody, "The grid challenges for renewable energy An overview and some priorities," IET Seminar on Integrating Renewable Energy to the Grid, pp. 1–24, London 2014.

6. G. Pathak, B. Singh and B. K. Panigrahi, "Permanent magnet synchronous generator based wind energy and DG hybrid system," IEEE Nat. Power Systems Conf. (NPSC), pp. 1–6, Guwahati, 2014.

7 .G. Pathak, B. Singh and B. K. Panigrahi, "Isolated microgrid employing PMBLDCG for wind power generation and synchronous reluctance generator for DG system," IEEE 6th India Int. Conf. Power Electron. (IICPE), pp. 1–6, Kurukshetra,2014.

8. P. J. Chauhan et al., "Fuel efficiency improvement by optimal scheduling of diesel generators using PSO in offshore support vessel with DC power system architecture," IEEE PES Asia-Pacific Power & Energy Engg. Conf. (APPEEC), Brisbane, QLD, 2015, pp. 1-6.

9. S. Mishra, D. Ramasubramanian and P. C. Sekhar, "A Seamless Control Methodology for a Grid Connected and Isolated PV-Diesel Microgrid," IEEE Trans. Power Syst., vol. 28, no. 4, pp. 4393-4404, Nov. 2013.

10. M. Datta, T. Senjyu, A. Yona, T. Funabashi and C. H. Kim, "A Coordinated Control Method for Leveling PV Output Power Fluctuations of PVDiesel Hybrid Systems Connected to Isolated Power Utility," IEEE Trans. Energy Convers., vol. 24, no. 1, pp. 153-162, March 2009.

11. R. W. Wies, R. A. Johnson, A. N. Agrawal and T. J. Chubb, "Simulink model for economic analysis and environmental impacts of a PV with diesel-battery system for remote villages," IEEE Trans. Power Syst., vol. 20, no. 2, pp. 692-700, May 2005.

12. B. Singh, R. Niwas and S. K. Dube, "Load Leveling and Voltage Control of Permanent Magnet Synchronous Generator-Based DG Set for Standalone Supply System," IEEE Trans. Ind. Informat., vol. 10, no. 4, pp. 2034-2043, 2014.

13. R. Niwas and B. Singh, "Solid-state control for reactive power compensation and power quality improvement of wound field synchronous generator-based diesel generator sets," IET Electric Power App., vol. 9, no. 6, pp. 397-404, 2015.

14. R. K. Agarwal, I. Hussain and B. Singh, "LMF-Based Control Algorithm for Single Stage Three-Phase Grid Integrated Solar PV System," IEEE Trans. Sust. Energy, vol. 7, no. 4, pp. 1379-1387, Oct. 2016.

15. J. C. M. Bermudez and V. H. Nascimento, "When is the least-mean fourth algorithm mean-square stable?," Proc. IEEE Int. Conf. Acoust. Speech Sig. Process., vol. 4, pp. iv/341-iv/344, Mar. 18-23, 2005.

Author's Profile:

Mr.T.Venkata Prasad received B.TechDegree in Electrical and Electronics from Sri Venkateswara University college of engineering, Tirupati, and M.Tech Degree in Power Electronics From J.N.T.U Hyderabad.Currently working as assistant Professor at Sree Venkatesara College of Engineering, North Rajupalem, Nellore ,Andhra Pradesh.

M.Sreedevi is currently pursuing B.Tech Degree in Electrical & Electronics Engineering from Sree Venkateswara College Of Engineering, North Rajupalem, Nellore ,A.P

V.Naveen Krishna is currently pursuing B.Tech Degree in Electrical & Electronics Engineering from Sree Venkateswara College Of Engineering, North Rajupalem, Nellore ,A.P