# Power Quality Improvement and Power System Unbalance Loading Improvement using Active Power Filter for Solar PV and Wind Integrated System

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*Abstract*— The deep integration of renewable energy resources, together with solar photovoltaic system (PV) and wind turbine (WT) energy, principally rely on the cheap technological improvement of worldwide emissions and therefore the precise techniques for power quality. Grid-connected inverters act as key elements in distributed generation systems for last technology. The electrical converter connects the renewable energy sources and power distribution network systems for the conversion of power. In grid-connected systems, many current and voltage harmonics have an effect on the system performances. Likewise, extremely unstable devices plus the growing demand for nonlinear masses and renewable energy resources influence the ability networks and systems performance in terms of power quality. The effective solutions to those issues are active filters (PFs), static volt-ampere generators, and active power filters (APFs). However, the utilization of PFs during a high-voltage system will increase its price, size, and weight. This study aims to assess the foremost advanced APFs by reducing the amount of power switches and concentrate on the reduction of price, size, and weight of grid-connected inverters. Many studies compared and evaluated reduced-switch-count APF electrical converter topologies, like AC–AC, consecutive, and customary leg, beneath the single-phase and three-phase systems. Recently, efficient solutions to cut back the amount of elements, transformer less inverters, construction and multifunctional inverters supported the APF in PV, and wind energy conversion systems are greatly explored. The present techniques and their limitations for developing advanced inverter-based devices for renewable energy systems are mentioned with justifications. Therefore, this review would doubtless facilitate industrial researchers improve power quality in PV and WT energies and power distribution network systems.

***Key words:*** Solar Photovoltaic System (PV), Wind Turbine (WT) Energy

## I. Introduction

The power demand invariably exceeds the accessible power generation in any developing country. Hence, renewable power generating systems like PV and wind energy conversion systems area unit accustomed supplement the fuel based mostly power generation. However thanks to the non-linearity of the load that's diode bridge rectifier with RL- load, there's harmonics within the load currents. Hence, harmonics reduction and reactive power compensation at the same time will be done by employing a voltage supply electrical converter connected in parallel with the system that acts as a shunt APF for reducing the distortions created thanks to non-linear load within the load current. This active filter generates a compensating current that is of equal in magnitude as harmonic current and opposite in section with it to cut back the harmonics gift within the load current.APF is classed as series, shunt or combination each series and shunt however shunt APF is most popular here because the principle of the shunt APF is to provide compensating currents of equal in magnitude however opposite in-phase to those harmonics that area unit gift thanks to non-linear masses. SAPF may be a control system structure wherever non-linear masses act as linear. It will compensate reactive power and might additionally mitigate harmonics and distortions.

Power quality phenomena embody all attainable things within which the wave form of the provision voltage (voltage quality) or load current (current quality) deviate from the curved wave form at rated frequency with amplitude equivalent to the rated rms price for all three phases of a three-phase system [1]. The data selection of power quality disturbances covers fast, short length variations, e.g. impulsive and oscillating transients, voltage sags, short interruptions, further as steady state deviations, like harmonics and flicker. One can even distinguish, supported the cause, between disturbances associated with the standard of the provision voltage and people associated with the standard of the present taken by the load [2].

To the primary category covers voltage dips and interruptions, principally caused by faults within the grid. These disturbances could cause tripping of “sensitive” instrument with unfortunate consequences in industrial plants wherever tripping of essential equipment will bear the stoppage of the full production with high prices associated. One will say that during this case it's the supply that disturbs the load. To avoid consistent cash losses, industrial customers usually commit to install mitigation instrumentation to safeguard their plants from such disturbances.

The second category covers phenomena thanks to inferiority of the present drawn by the load. During this case, it's the load that disturbs the supply. A typical example is current harmonics drawn by worrying hundreds like diode rectifiers, or unbalanced currents drawn by unbalanced hundreds. Customers don't expertise any direct production loss associated with the incidence of those power quality phenomena. However poor quality of the present taken by many purchasers along can ultimately lead to inferiority of the facility delivered to alternative customers [3]. Each harmonics and unbalanced currents ultimately cause distortion and severally, unbalance within the voltage likewise. Therefore, correct standards are issued to limit the amount of harmonic currents, unbalance and/or flicker that a load could introduce. To accommodate limits set by standards, customers usually got to install mitigation instrumentation.

## II. PROPOSED METHODOLOGY

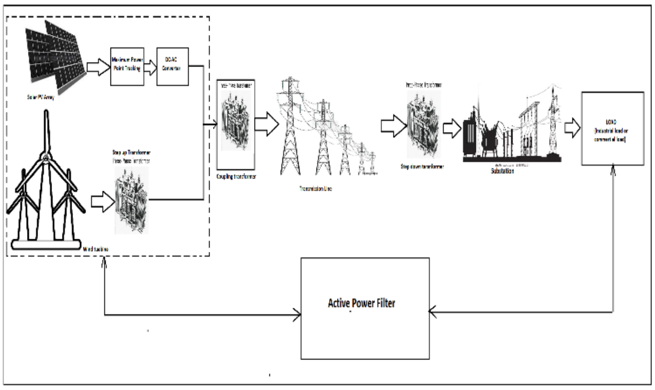


Fig.1. Block diagram of proposed approach

Figure 1 shows the proposed system block diagram in which solar and wind turbine system connected and synchronized with AC grid system. Active power filter is connected with AC grid system which use for minimization power quality disturbance minimization. This active power filter is working based on comparison of phase difference of three phase voltage at solar and wind system as well as at load side or AC grid system.

## III. MATLAB SIMULATION MODEL

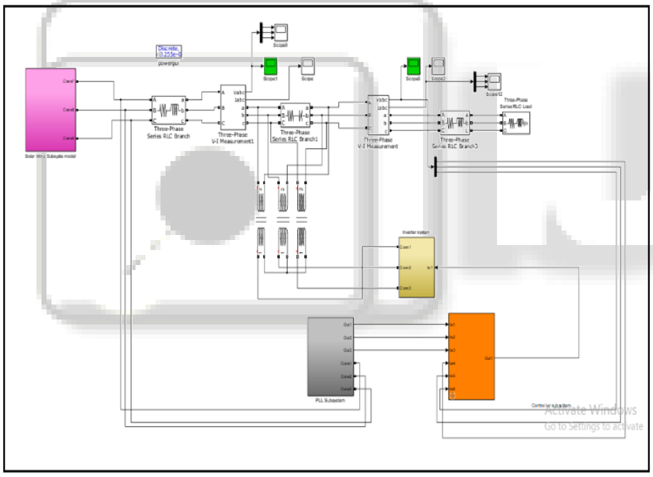

Fig.2. Proposed matlab simulation model

### *A. PV susbsysem model*

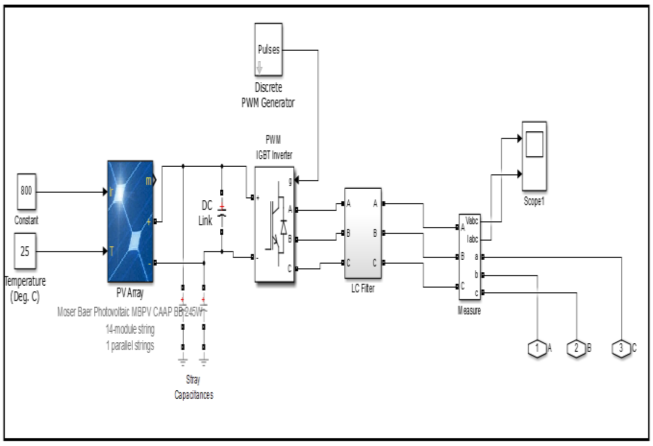


Fig.3. MATLAB Simulink subsystem model for solar pv inverter system

| Sr No | Name of block | Specification |
|---|---|---|
| 1 | PV Array | Parallel string = 1; Series connected modules per string = 14; Module name = Moser Baer MBPV CAAP BB 245W; Maximum power = 245 W; Cell per module=60; Open circuit voltage (Voc) = 37.77V; Short circuit current (Isc=8.37A; Voltage at maximum power point Vmp (V) = 30.85; Current at maximum power point Imp (A) = 7.79 A |
| 2 | PWM IGBT Inverter | Snubber resistance = 5000 Ohm; Number of bridge arm = 3; Ron = 1MOhm |
| 3 | LC Filter | Inductor L = 20mH; Capacitor C = mVar |

TABLE I: PV subsystem MATLAB simulink model parameter specification

### *B. Wind turbine subsystem*

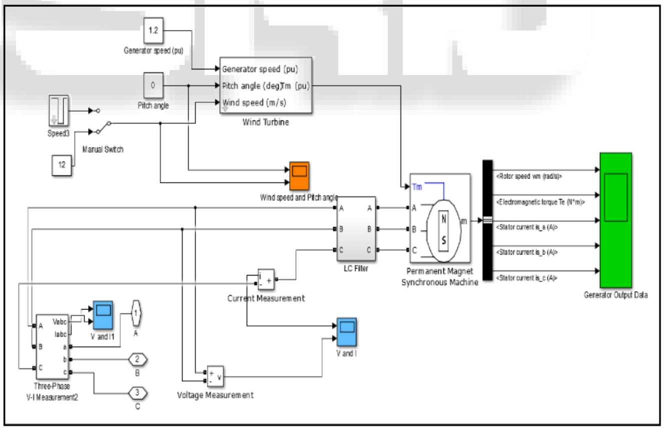


Fig.4. MATLAB Simulink subsystem for wind turbine system

| Sr No | Name of block | Specification |
|---|---|---|
| 1 | Wind turbine | Nominal mechanical power = 200W; Base power of electrical generator = 200/0.9 VA; Base wind speed = 12m/s; Maximum power at base wind speed = 0.73pu; Base rotational speed = 1.2pu; Pitch angle = 0 degree. |

 

| | | |
|---|---|---|
| 2 | Permanent magnet synchronous machine | Number of phase =3; Rotor type = Round; Mechanical input = Torque; Stator phase resistance =0.0018 Ohm; Armature inductance = 0.000835 H |

TABLE II: Wind turbine subsystem MATLAB simulink model parameter specification

### *C. Series Acive Power Filter*

The active filter in these configurations produces a PWM voltage waveform which is added/subtracted, on an instantaneous basis, to/from the supply voltage to maintain a pure sinusoidal voltage waveform across the load. The main power-circuit configurations is shown in figure 5.

Series active filter is to be placed in series between the ac source and the load (or harmonic source) to force the source current to become sinusoidal. The approach is based on a principle of harmonic isolation by controlling output voltage of the series active filter. In other words, the series active filter is to present high impedance to harmonic current, therefore blocking harmonic current flow from the load to the ac source and from the ac source to the load side.

The main advantage of series filters over parallel ones is that they are ideal for eliminating voltage-waveform harmonics, and for balancing three-phase voltages. This, in fact, means that this category of filter is used to improve the quality of the system voltage for the benefit of the load. It provides the load with a pure sinusoidal waveform, which is important for voltage-sensitive devices.

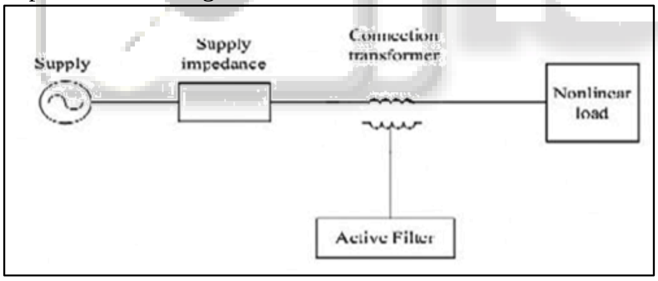


Fig.5. Series active filter configuration

A simple algorithm is developed to control the series and shunt filters. The series filter is controlled such that it injects voltages ($V_{ca}$ ,$V_{cb}$ ,$V_{cc}$ ) which cancel out the distortions and/or unbalance present in the supply voltages ($V_{sa}$ ,$V_{sb}$ ,$V_{sc}$) thus making the voltages at the PCC ($V_{la}$ ,$V_{lb}$ ,$V_{lc}$ ) perfectly balanced and sinusoidal with the desired amplitude. In other words, the sum of the supply voltage and the injected series filter voltage makes the desired voltage at the load terminals. The control strategy for the series AF is shown in figure 6.

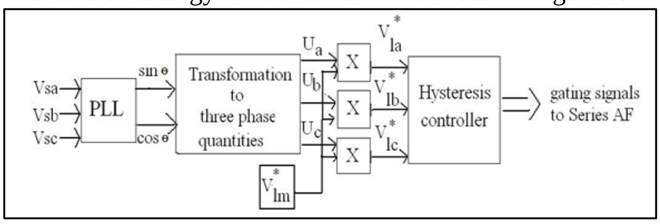


Fig.6. Control Scheme of Series APF

## IV. MATLAB SIMULATION RESULTS

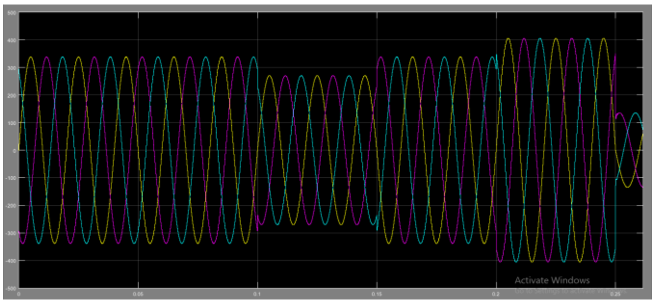

Fig.7. Three phase voltage at receiving end of transmission line due to solar and wind turbine variations.

Figure 7 shows the three phases voltage affected due o solar and wind turbine non-linear power generation due to atmospherical conditions. That conditions was occurred due to solar irradiation and temperature effect on solar pv panels. Also similarly in case of wind turbine, output voltage variation was occurred due to wind speed variations and wind turbine blade angle variations.

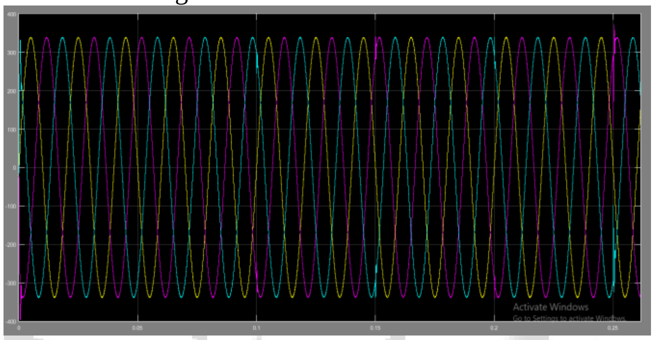

Fig.8. Three phase voltage at receiving end of transmission line due to active power filter correction.

Figure 8 shows the three phases voltage at receiving end of transmission line which was conditioning by active power filter. It is clear that at sending end voltage abnormal conditions was completely eliminate at receiving end using active power filter.

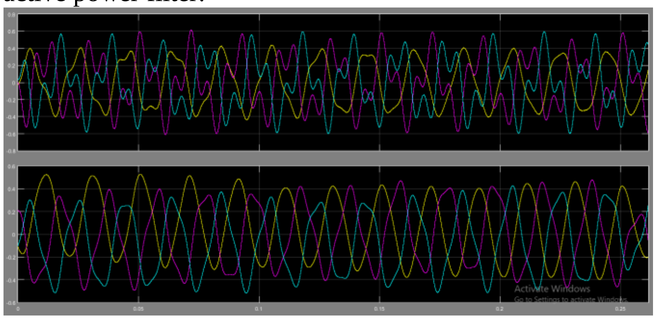

Fig.9. Solar PV generated three phase voltage and current waveform

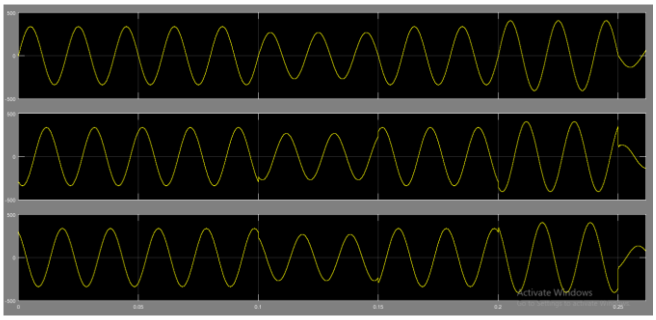

Fig.10. Three phases voltage generated by wind turbine.

## V. CONCLUSION

This paper present the technique for improvement of power quality disturbances due to nonlinear nature of solar and wind turbine system connected with grid. That power quality disturbance is disturb the power system grid which may cause harmonics, voltage interruption and voltage fluctuations. In this paper active power filter is used for power quality disturbance improvement using receiving end and sending end voltage comparison basis logic controller.

It is clear that this technique is very much useful for improve the power quality disturbance at receiving end of transmission line which developed by solar and wind turbine systems amosperical condition.

## REFERENCES

[1] M. P. Collins, W. G.Hurley, and E.Jones, "The application of wavelet theory in an expert system for power quality diagnostics," 30th Universal Power Engineering Conference, 1995.

[2] C. Xiangxun (2002).Wavelet-based detection, localization, quantification and classification of short duration power quality disturbances. IEEE PES Winter Meet, 2, pp.931-936.

[3] Hamid E. Y. and Kawasaki Z.-I (2002).Wavelet-based data compression of power system disturbances using the minimum description length criterion. IEEE Trans. Power Delivery, vol. 17 (no.2), pp. 460-466.

[4] Bhim Singh and venkateswarlu.P, "A Simplified C ontrol Algorithm for Three-Phase, Four-Wire Unified Power Quality Conditioner" Journal of Power Electronics, Vol. 10, No. 1, January 2010 pp.91-96

[5] S.K. Jain, P. Agrawal and H.O. Gupta, "Fuzzy logic controlled shunt active power filter forpower quality improvement"IEEE Proc eedings on Elect.Power.Appl.Vol 149.No.5,September 2002.

[6] Kiselychnyk, Oleh, Marc Bodson, and Jihong Wang. "Linearized state-space model of a self-excited induction generator suitable for the design of voltage controllers." *IEEE Transactions on Energy Conversion* 30.4 (2015): 1310-1320.

[7] Attia, Hussain A. "Three steps AC voltage regulator based on one step-down transformer." International Journal of Applied Engineering Research 10.19 (2015): 39898-39902.

[8] Alam, M. Rabiul, et al. "Single phase automatic voltage regulator design for synchronous generator." International Journal of Electrical & Computer Sciences IJECS-IJENS 11.05 (2011): 37-42.

[9] Swain, Sushree Diptimayee, Pravat Kumar Ray, and Kanungo Barada Mohanty. "Improvement of power quality using a robust hybrid series active power filter." IEEE Transactions on Power Electronics 32.5 (2017): 3490-3498



 