Power Quality Enhancement of Micro-grid Linked System by Using STATCOM

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***Abstract*— A micro grid is a discrete power device which includes distributed energy resources able to run in tandem or independently from the precept grid. nowadays the preceding one is favored. The clever interconnection of allocated energy property determines the first rate of the power provided by means of using the energy delivered. it's miles acquired by using way of the best management techniques of micro-grids. This assignment offers with the adaptive manipulate approach for micro-grid which includes sun photovoltaic systems and wind energy structures. sun photovoltaic structures are grid interfaced through electricity digital converters and the wind power system through induction mills. The proposed controller is answerable for the efficient transfer the energetic energy and strength element improvement. The check gadget and the controller operation is demonstrated using MATLAB /Simulink.**

***Keywords*— *microgrid ; voltage source inverter; adaptive controller* .**

I. INTRODUCTION

As electrically powered distribution era steps into the following century, many trends are becoming important that will exchange the requirements of power delivery. these changes are being driven by using each the call for side wherein better electricity availability and efficiency are preferred and through the delivery facet where the integration of disbursed generation and peak shaving technologies.

Electricity grids enable the delivery of electrical strength from manufacturing to consumption centers, by keeping an appropriate reliability and voltage quality for all clients at the bottom feasible charge. The trade or shift from big manufacturing devices to smaller ones results in the formation of disbursed power (DG) assets. The DGs are the manufacturing devices linked to the distribution network as well as huge manufacturing units primarily based on renewable electricity resources. The reasons for the introduction of latest manufacturing gadgets to power systems stems from the subsequent [1]:

1. Open energy markets
2. Environmental factors
3. Thin margins between the highest consumption and the likely available production
4. Growth in electricity consumptio

II. MICRO GRID TOPOLOGY

A Micro-grid is a scientific employee of DG structures and consequently has a bigger potential and greater control flexibility to complete system reliability and electricity excellent necessities. a regular micro grid including Photovoltaic structures, wind energy systems and conventional era machine. the use of grid-connected inverters allows the efficient control of power generated through the micro assets and the generation of reactive electricity near the load, ensuring in the good sized reduction of losses. Consequently, high-overall performance algorithms for power flow manager and voltage law are required. The control algorithms of every individual DG device need to be based on feedback variables that can be measured locally. Additionally, they have to make certain a secure operation of the micro grid, averting instability troubles that may occur especially while many DG systems are positioned in the identical area. the usage of manipulating strategy for grid-linked inverters allows the active contribution of the micro resources, adapting themselves to the variation of the grid traits.

The management strategy is evolved in order to integrate the benefits of the current control and the voltage control techniques; the former is to be preferred to make sure stability of the whole conversion gadget, whilst the latter one permits an extra correct era of the reference voltages vital to use the heartbeat Width Modulated (PWM) voltage method. The DG structures within the Micro-grid are normally powered by means of emerging technology which includes photovoltaic or wind-energy and geared up via inverters to interface with the electrical distribution system. The important trouble with this technology is the nature of the technology; certainly, the supply of their energy supply is ruled by using the climate and now not by means of masses of the systems. those resources

are intermittent and must ideally be operated at their most output.

The principle objective of the thesis is to increase a control method for reactive electricity waft manipulate of the microgrid similar to intermittent electricity technology of the DGs. And also the efficient transport of the energy produced by the PV - DG at variable sun incidence. that is achieved by means of the most energy factor tracking algorithms. The file has been organized into six sections. segment III contains the literature survey concerning the principle thesis. The design of micro-grid is indexed in the IV segment. segment V covers the simulation component. segment VI forms the belief.

III. LITERATURE REVIEW

Colet-Subirachs et al[2] describe the manipulate algorithm of an application linked micro-grid, based totally on an independent manager of lively and reactive energy (PQ manipulate). and operating in centralized operation mode. The microgrid underneath investigation consists of 3 configurable gadgets; a generation unit, a garage unit, and a load. those gadgets are interfaced with the microgrid thru a Voltage Source Converter (VSC).

Hamlyn et al[3] proposed an adaptive management approach for interfacing DGs from wind energy to application distribution grids. This paper presents the voltage manipulate requirements and protection requirements for wind-powered DGs consistent with IEEE-1547 standards. It defines adaptive interfacing controller for 3 common varieties of wind-powered DGs; doubly fed induction generator, permanent -magnet synchronous generator, and squirrel-cage induction generator.

Munir and Wei Li [4] describes the capacity of using PV interfacing inverters. With the growing implementation of DG in residential areas, using DG system to enhance the strength first-class is a promising idea. maximum DGs have grid interfacing inverters. for this reason inverter control promise to be the first-class answer for power nice development.

Toodeji et al [5] introduce an incorporated system of PV module and STATCOM. The DC-DC converter for optimum power point monitoring(MPPT) changed into eliminated and STATCOM saved the PV module in its premier running factor in different situations of ambient temperature and solar radiation. elimination of DC-DC converter results in reduce value and size of gadget. To discover the most efficient voltage of PV module in every condition, perturbation and observation(P & O) method became used.

Mohamed and Osama [6] investigated a number of the components associated with the connectivity of DC microgrids to the principle grid. a fully controlled rectifier is designed to tie the DC grid with the AC one. A vector decoupling managed Sinusoidal Pulse Width Modulation (SPWM) method has been used to allow the designed rectifier to maintain a consistent output voltage and allow to control the energetic and reactive power drawn from the grid. so that you can maximize the running variety of the managed rectifier, an adaptive controller is used. The proposed controller is a Proportional crucial [PI] controller that has been tuned at distinctive working tiers. Then, a fuzzy controller is used to pick out the maximum appropriate PI parameters primarily based on the loading circumstance.

Khorramabadi and Bakhshai [7] offered an adaptive power manipulate scheme capable of on-line mastering and self-tuning for microgrid packages. A fuzzy common sense inspired critic-based totally control is mixed with conventional PI regulators to consolidate intelligence and robustness in the machine. The manipulate scheme is a self-tuning and adaptive manipulate with online mastering functionality. In grid connected mode, the power technology of DG devices is directly determined based at the assigned electricity references.

Laaksonen and Kauhaniemi [8] proposed a concept to apply the existing solar Farm (SF) inverter as a STATCOM at some stage in night time to modify voltage versions on the percent due to extended and intermittent WF electricity and/or through load versions. The controller consists of PI primarily based voltage-law loops. A hysteresis contemporary controller is applied to perform switching of inverter switching. This strategy of PV solar farm manage will facilitate integration of greater wind flora inside the system without needing additional voltage-regulating devices.

IV. BASIC SYSTEM CONFIGURATION

The proposed device consisting of the photovoltaic DG machine, wind power conversion device, principal distribution grid and related masses. Fig.1 indicates the simple system configuration of micro-grid.

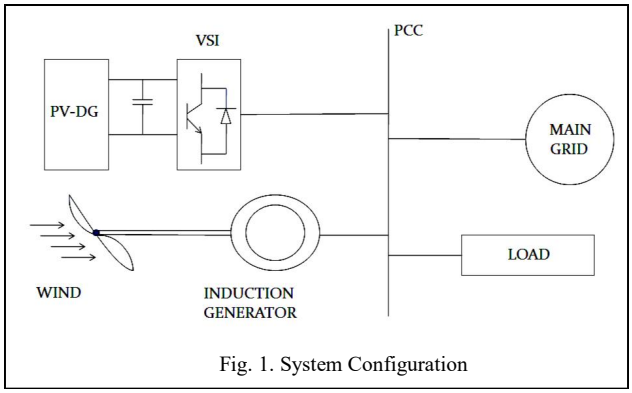

Fig. 1. System Configuration

A. Photo Voltaic DG System

Photovoltaic systems are interconnected to the grid via VSI. A dc-dc improve converter is hired between the PV and Voltage source inverter. The position of the DC-DC converter is to track the maximum electricity from the PV and supply the maximum to the central aspect of VSI. simple additives inside the grid interconnected PV-DG is proven in Fig..2

The extracted strength from PV module could no longer be superior and consequently, will negatively affect the performance of a PV gadget. since the module performance is low, it's miles ideal to operate the module at the height energy point so that the maximum electricity may be brought to the burden beneath varying temperature and irradiation situations.

This maximized strength allows improving using the solar PV module. An MPPT extracts maximum strength from the PV module and transfers this electricity to the burden. As an interfacing device, DC-DC converter transfers this maximum electricity from the solar PV module to the weight. by using changing the responsibility cycle, the weight impedance is various and matched on the factor of the height strength with the supply so one can transfer the maximum electricity.

A dc-dc raise converter is used to extract most energy from PV module. those are switching energy converters. efficiency, length, and cost are the primary blessingsof

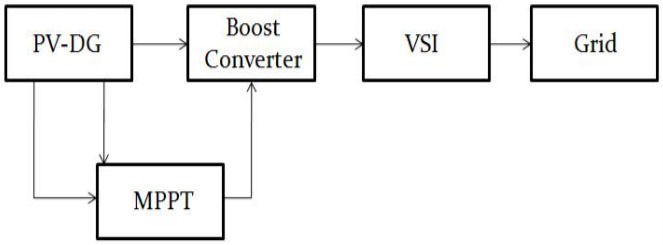

Fig. 2. Block Diagram of Grid Connected PV DG

switching power converters in comparison to linear converters. Switching strength converter efficiencies can run among 70-eighty%, while linear converters are generally running at 30%.The converter between PV module and inverter units the PV module at its foremost operating factor. those converters commonly alter PV voltage at the most effective fee that is located with the aid of MPPT algorithms.

Numerous MPPT methods are present like Perturbation and observation, Incremental Conductance method and many others. in this paper, incremental conductance method is used for tracking most power from the PV panel. Fig 3 indicates the

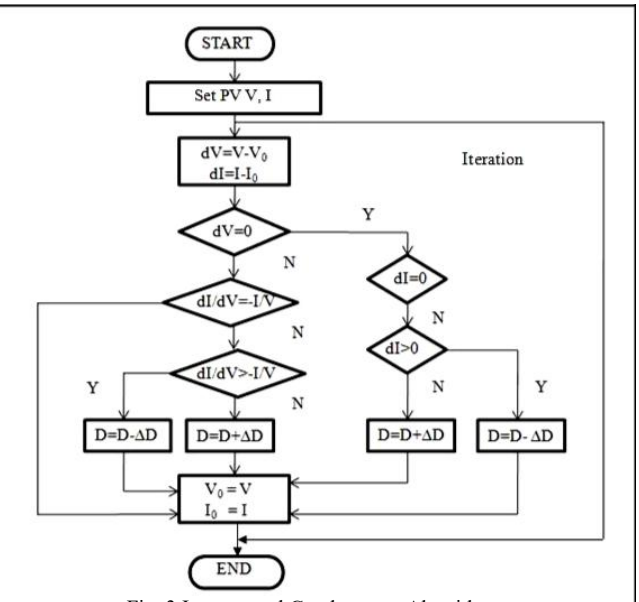

Fig. 3.Incremental Conductance Algorithm

incremental conductance algorithm and is the reason the operating of most electricity point tracker.

DG gadgets require energy electronics interfaces and extraordinary techniques of manage and dispatch. A DC-AC voltage supply inverter (VSI) is maximum extensively used as an interface for DG devices,which entails many topologies and manipulate aspects below different running conditions. This involves P and Q manipulate underneath various nearby load traits and running situations.

B. Wind DG System

The generator in fixed-speed wind mills is the induction kind generator linked without delay to the grid. Synchronous generators had been used in some early prototypes but the induction device has been extra broadly adopted because of decrease value, stepped forward environmental durability and a superior mechanical compatibility with speedy wind variations.

The generator collectively with a gearbox is placed in a nacelle on the pinnacle of the tower. The feature of the gearbox is to alternate the low rotational velocity of the turbine to an excessive rotational velocity on the generator side. The rotational velocity of an induction generator is generally a thousand or 1500 rpm. a set-velocity wind turbine[9] is designed to obtain most performance at one wind velocity to be able to deliver the most suitable tip velocity to wind velocity ratio for the rotor airfoil.

V. MICROGRID DESIGNING

The equivalent circuit of a PV mobile is proven in Fig.4. It includes a present day source, a diode, a series resistance and a shunt resistance [10] The V-I function equation of a PV cellular is given as:

$$I = I_{ph} - I_s \left(\exp\left((q(V+I R_s)/ k T A) - 1 \right) \right) \quad (1)$$

Iph is a light -generated current or photocurrent,
Is is the cell saturation of dark current,
q (1.610^{-19} C) is the electron charge,
k (1.3810^{-23} J/K) is Boltzmann constant
T is the cell working temperature
A is the diode ideal factor
R_{sh} is the shunt resistance
R_s is the series resistance

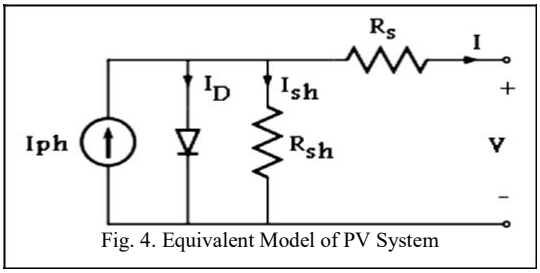

Fig. 4. Equivalent Model of PV System

layout of improve converter inductor and capacitor is given in detail. The inductance is calculated such that the inductor contemporary IL flows continuously and by no means falls to 0. as a consequence, L is given via

$$L_{min} = (1 - D^2) * DR/2f \quad (2)$$

The output voltage ripple is decided with the aid of the collection impedance of the capacitor and the output modern-day. The output capacitance to offer the favored output voltage ripple is given via

$$C_{min} = D/(R*f*V_r) \quad (3)$$

The kinetic electricity (KE) in air of mass m shifting with velocity V , is given by way of the subsequent in SI units [9] :

$$K.E = ½ * m* V^2 \quad (4)$$

The power in moving air is the flow price of kinetic power according to 2nd.

$$P = ½ * V^2 * \text{mass flow rate per second} \quad (5)$$

PI controller is delivered for the DC voltage regulation. this will make sure the most strength monitoring of PV system and also the efficient load delivery with the aid of the microgrid and the primary grid.

at once connected wind energy device absorbs reactive modern from the grid for excitation. The reactive energy management approach used for microgrid manage is defined by the following equation 6 . the following section famous the role of controller.

$$Q^* = (Q_{load} + Q_{wind}) - (P_{load} - (P_{pv} + P_{wind})) \tan\theta^* \quad (6)$$

VI. SIMULATION RESULT

The Sun power E20/330, PV panel was chosen for modeling and simulation the usage of MATLAB/Simulink. The module has ninety-two cells that are linked in series. the electrical specifications are shown in Table 1.

Table 1. PV Panel Specification

1	Maximum power	330W
2	Voltage at V_{max} (V_{max})	54.7V
3	Current at P_{max}	6.09A
4	Short circuit current	6.46A
5	Open circuit voltage	65.3
6	Maximum System Voltage	1000V

The configuration of PV gadget constructed in Simulink is proven in Fig.5. The PV and IV traits are proven inside the Fig.6 and Fig.7.

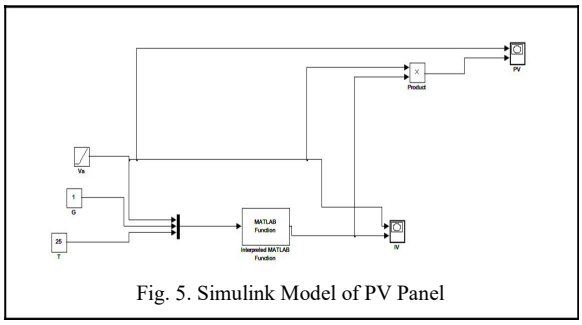

Fig. 5. Simulink Model of PV Panel

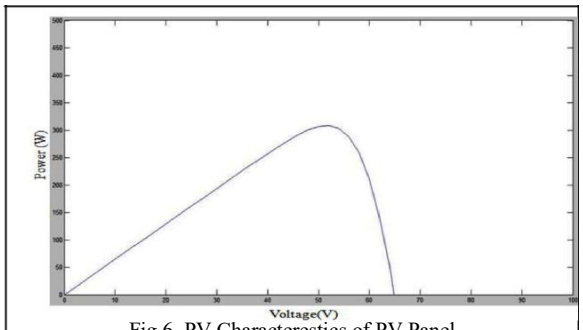

Fig.6. PV Characterestics of PV Panel

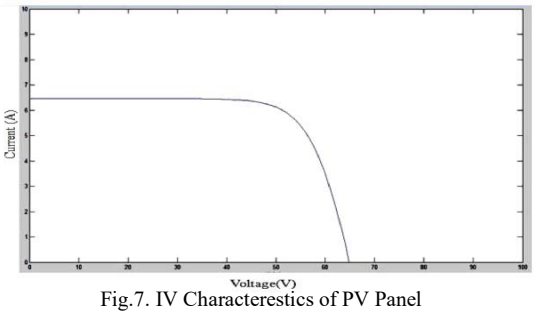

Fig.7. IV Characterestics of PV Panel

Fig.8 shows the PV-DG machine linked to the grid. 1KW load is used for simulation.

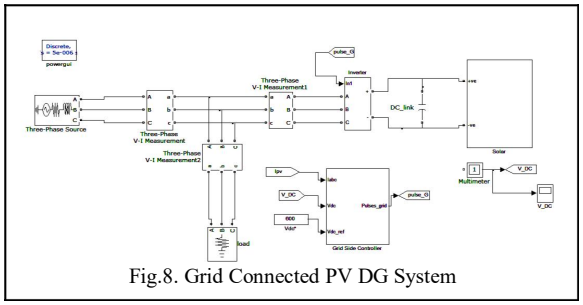

Fig.8. Grid Connected PV DG System

The proposed manipulate method with DC link voltage manage ensures the efficient delivery of the PV maximum electricity production at each radiation stage. Fig.(shows the DC link voltage controller for PV DG device. It consists of PI controllers.

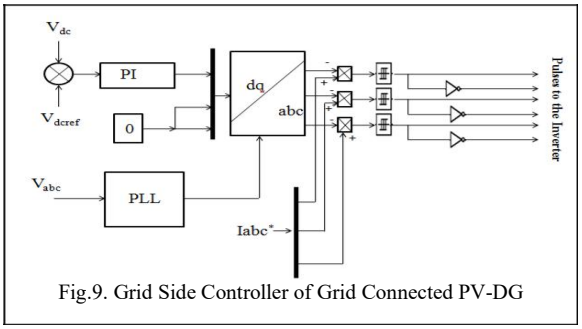

Fig.9. Grid Side Controller of Grid Connected PV-DG

it's far found that each the PV and the primary grid offers active strength reliability to the load. Fig.10 a,b,c shows the

the accuracy of the PV VSI controller for grid synchronization and interconnection.Fig.11 shows the grid aspect reactive power. It reveals the position of DC hyperlink voltage controller for grid synchronization and the interconnection.

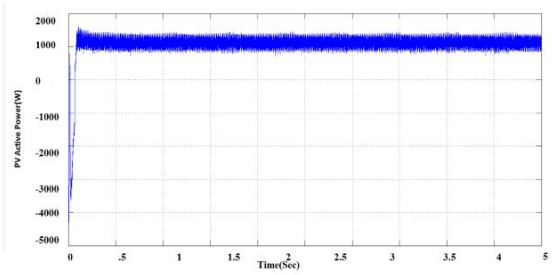

Fig.10. a) PV Active Power

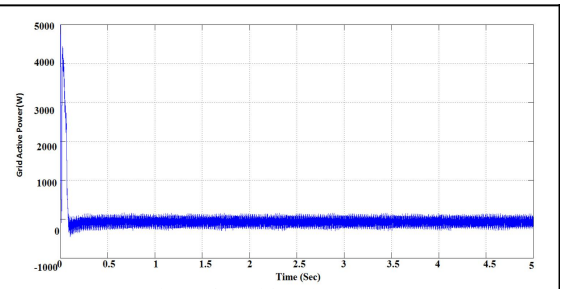

Fig.10. b) Grid Active Power

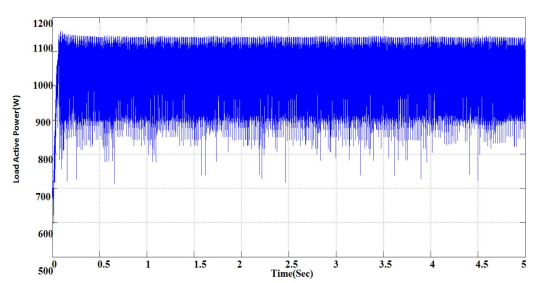

Fig.10. c) PV Active Power

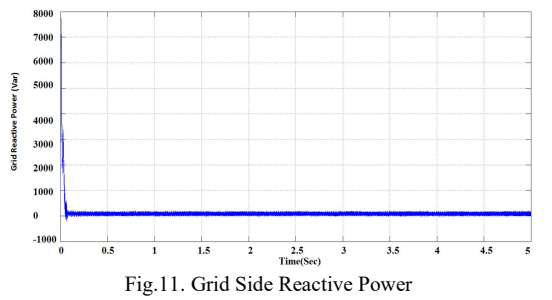

Fig.11. Grid Side Reactive Power

Fig.12 suggests the micro grid gadget connected to the grid. it's far found that the micro grid and the main grid deliver energetic energy to the patron load below exclusive radiation levels of the PV-DG machine, which reveals the accuracy of the inverter primarily based grid controller for grid synchronization and interconnection.

The modern controller used for grid related mode operation of microgrid to the software grid is shown in Fig.13. It include one PI controller and two PI controller for reactive electricity management. One for the active power and the opposite one for reactive energy manipulate.

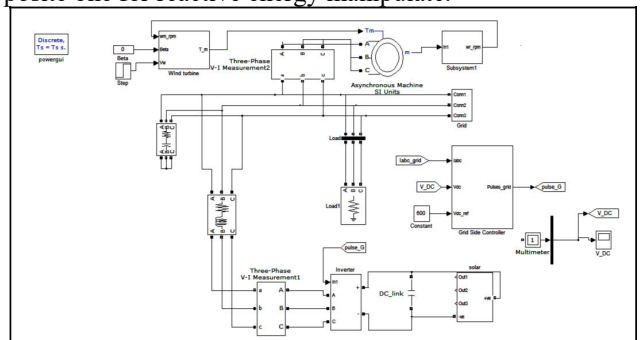
Fig.12Grid Connected Microgrid

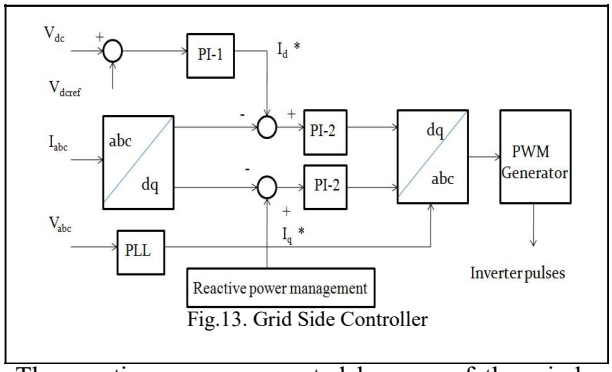

Fig.13. Grid Side Controller

The reactive power generated by way of the wind, grid and PV gadget Fig.14,15,16,17 . The PV machine generates the reactive electricity required on the grid side and continues the grid reactive

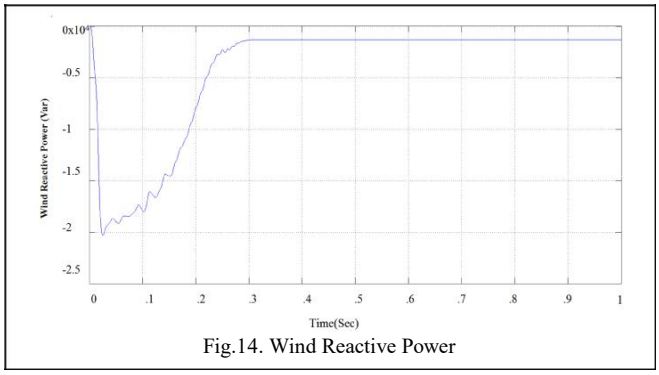

Fig.14. Wind Reactive Power

energy about to 0. This continues the entire.

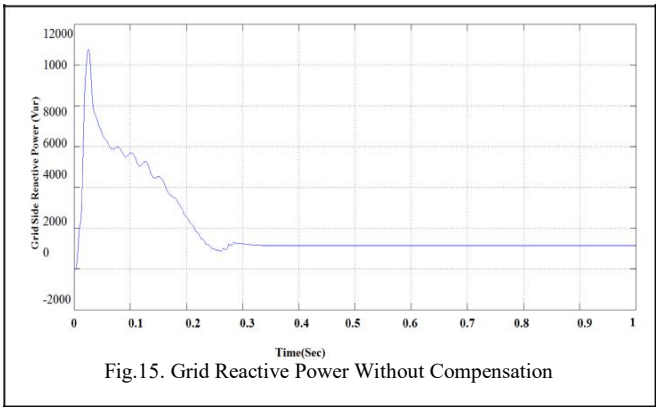

Fig.15. Grid Reactive Power Without Compensation

device strength element to unity. The device power thing is shown within the Fig.18. The strength component is maintained to 0 .nine.

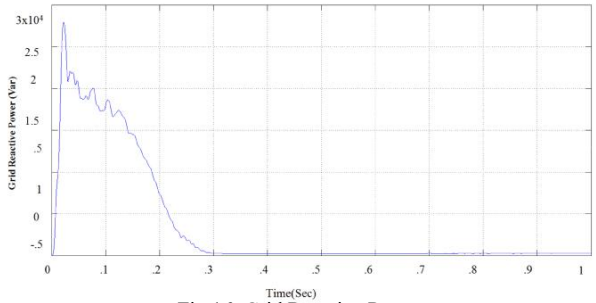

Fig.16. Grid Reactive Power

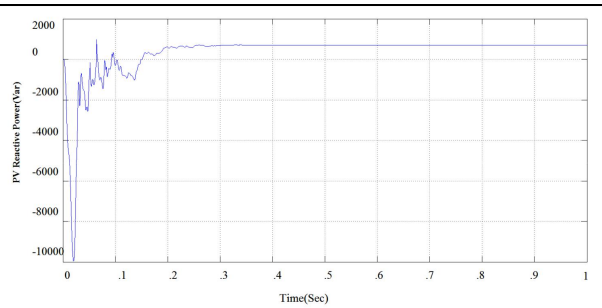

Fig.17.PV Reactive Power

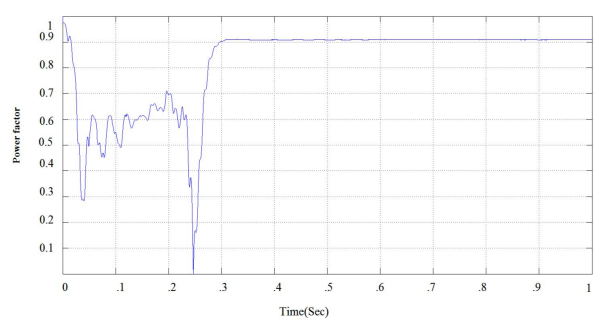

Fig.18. Power factor

VII. CONCLUSION

The modeling of hybrid micro-grid for electricity gadget configuration is completed in MATLAB/SIMULINK environment. The work especially covers the grid tied mode of operation of hybrid micro-grid. The impact of wind DG gadget at the grid is compensated by the PV inverter. The proposed hybrid wind and solar has two benefits; it replaces the compensators (ie STATCOM gadgets and Capacitor banks) and the effective use of renewable resources.

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