THE USING OF PV SOLAR FARM AS STATCOM (PV STATCOM) FOR THE CONTROLING INCREASING GRID POWER TRANSMISSION LIMITS DURING NIGHT AND DAY

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Abstract: **The comprehensive testing, validation, and the installation plan for the pv solar the New. Technology which is utilizes for (PV), solar farm as, STATCOM during the, night and Day time. This Technology is termed as a STATCOM. It will be the utilized in the night for power factor correction and voltage control at the terminals of an induction motor. This paper is the discussed including many applications of proportional-integral (PI), controllers method. However, the previous works is obtained the PI gains via a trial and error hence; the control parameters for optimal performance at a given operating point may not be as effective at a different operating point. Here we present a method of using PV solar plant as STATCOM, in the dark periods without sunlight, for the load reactive power compensation and the voltage control. In this simulation model the adaptive PI control shows consistent and the excellence under the various operating conditions. The different initial control gains, and the different load levels, and change of the Transmission network, consecutive disturbances, and the severe disturbance. The conventional (STATCOM), control with tuned, fixed PI gains usually**

Index Terms: : **Photovoltaic cell (PV Cell), PI Controller, FACTS, (STATCOM), Distribution systems, Reactive Power Compensation, Power Factor Voltage Regulation, Active Power Reactive power**

I. INTRODUCTION:

The Utilization of renewable energy comes from the perspective of environmental conservation and fossil fuel shortage. The Recently studies and give suggested the medium and long terms photovoltaic cell (PV), generator will be becoming commercially so that the attractive large scale Of implementation in this type can be seen the many parts (pv) solar in the world [1], [2].The large-scale of (PV), generation system includes photovoltaic array (DC/AC).The converter and the associated controllers. It is the multivariable and the non-linear system and it is performance depends on environmental conditions. The Recently time increasing penetration levels of the PV solar plants are the raising concerns to the utilities due to possible negative impacts on the power system stability as speculated by a number of The, studies. Thorough investigation of the power system stability with the large-scale (PV), is the urgent task. In the extra situation new lines may need to the constructed at a very high expensive The Cost of effective techniques therefore need to be explored to the increase transmission capacity. After the novel research has been done reporting on the night time and the usage of the PV solar farm (when it is normally dormant),where the PV solar farm is utilized as a Static Compensator (STATCOM),The FACTS devices the performing voltage control, and thereby the improving ,The system performance and increasing grid connectivity of neighboring wind farms. The Now time solar energy using PV Technology is becoming popular due to the government subsidies. Obviously Thee solar forms generated Energy during sunny periods only. When The sunlight is not bright enough then they remain idle. To make The PV technology is the costly effective with higher utilization factor it is to be use throughout day and night. Efforts are being made in this direction [7,11]. The Power quality is an important aspect of power distribution. Power is to be distributed with tolerable voltage sags and swells. Here Flexible AC Transmission Systems (FACTS) devices play a vital role. It is well known that the Static synchronous Compensator (STATCOM) is a FACTS device which acts as a shunt compensating device. The key component of the PV solar plant is a voltage source inverter which is The also a core element of STATCOM. Power compensation and the voltage control. Due to the improvement in power factor load current reduces. It is Also the system remains balanced with better efficiency (less transmission losses), and power quality. This photvolitc paper presents is only a use of the PV solar farm inverter as the STATCOM and FACTS device for the voltage control and the power factor control , during both for the voltage control and power factor correction has been developed which is provides voltage regulation and the load compensation in the nights using the entire capacity of the existing solar systems inverter. During day time and it is also, the solar system is made to operate, as a STATCOM using its remaining inverter capacity, (left after what is needed for real power generate).

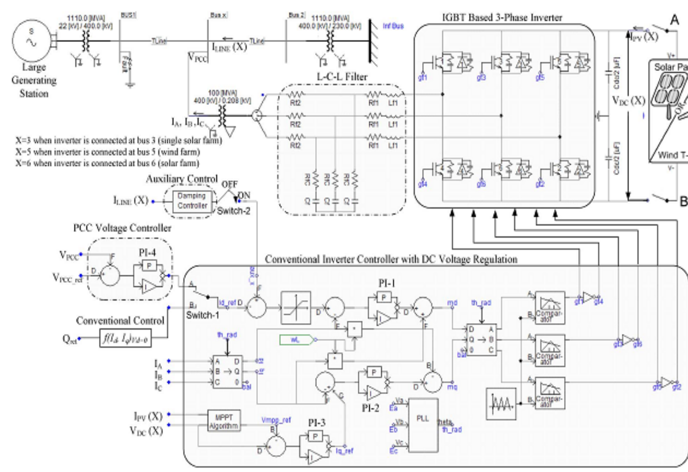

Fig.1: Complete DG (solar/wind) system model with a PI controller.

II. ABOUT PHOTO VOLTAIC SYSTEM:

A photovoltaic PV system is the directly converts sunlight into the electricity. The basic device of (PV), system is the PV cell. Cells may be grouped to form panels or arrays. The voltage and current available at the terminals of, Cell (PV), the device may directly feed small loads such as lighting systems and the, dc motors. [7] A photovoltaic cell is basically a semiconductor diode whose 9 (p–n), junction is exposed to light. Photo voltaic cells are made of the, several types of semiconductors using different manufacturing processes. The incidence of light on the cell generates charge carriers that originate an electric current if the cell is short circuited.

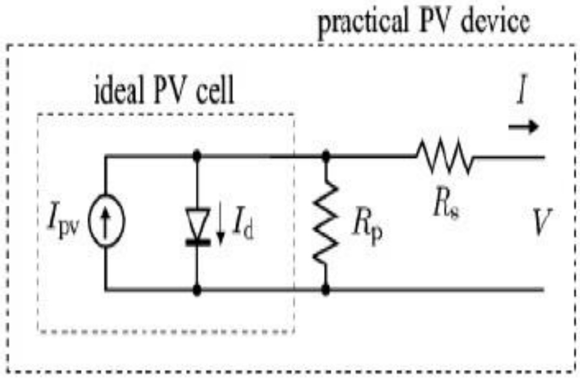

Fig.2: Equivalent Circuit of a PV Device including the series and parallel Resistances.

The equivalent circuit of the (PV), cell is shown in the Fig.2: In the above diagram the PV cell is represented by a current source in the parallel with diode. (Rs and Rp), represent series and parallel resistance respectively. The output current and voltage from (PV), cells are represented by I and V.

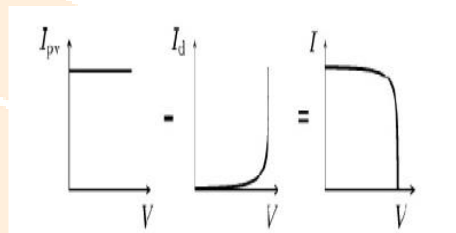

Fig.3: V-I Characteristic of PV Cell

III. OPERATION OF A PV SOLAR SYSTEM:

The below fig.4: shows the typical output of a tracking system based on a cloudy day. It is clearly seen that the entire capacity of the inverter is available in the night from 6 pm to 6 am to be utilized for them. Reactive power support as (STATCOM), during the day in the early mornings and late evenings a substantial amount of the reactive power capability is still available for the (PV). System to the operate as STATCOM

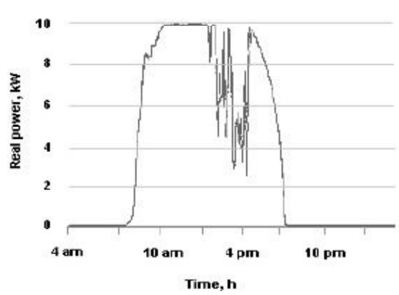

Fig.4: Typical output of a solar system

IV. PV SOLAR SYSTEM CONTROLLER DESIGN:

The controller design for a Pv solar system to the operated as a STATCOM is the presented in this section. The objectives of this control are to improve voltage regulation and power factor. The simulation model for the controller is built using MATLAB software. Fig.5: shows the power circuit of the photovoltaic (PV), solar farm model connected. with the components parameters. The PV solar panels are lumped together and the presented as a dc source, interfaced with the grid by means of a (IGBT), based, 6-pulse voltage source inverter (VSI), and inductors (L).The interface inductors (L), together with the filter capacitors C are used to filter output of the switching harmonics produced by inverter

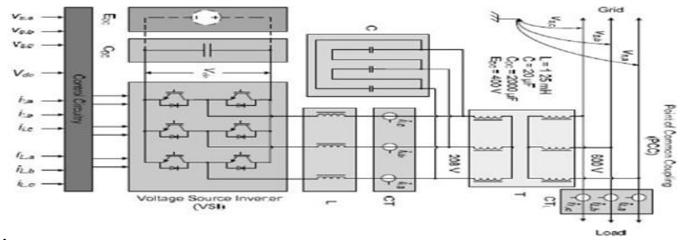

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Fig.5: power circuit ofPV solar system controller design

V. VOLTAGE CORRECTION:

A Steady State Performance:

The PV solar system acts as a STATCOM for The providing voltage support during the night time and with the full rated inverter capacity, and during the day time with the inverter capacity remaining after real power generation capability of PV solar system during night time while connected to a(45KVA), transformer is shown in the Fig.6:As the expected the voltage capability increases with the size of the PV solar system

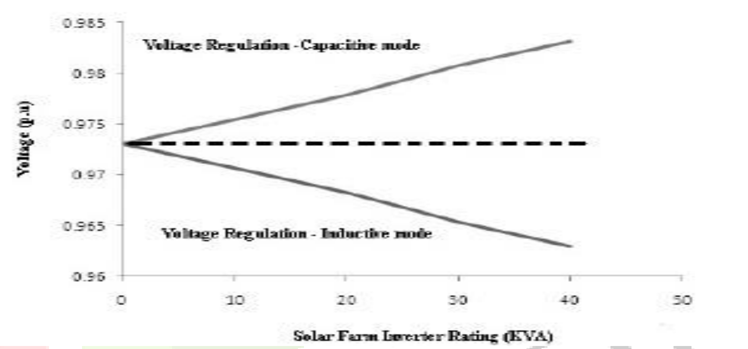

Fig.6: Voltage regulation capability of different rating of PV Solar Systems.

B. Transient performance

The transient response of controller of the PV solar system following a 5 cycle .three phase fault at a neighboring substation is shown in the Fig.7: The fault occurs at 0.20seconds. The PV inverter controller responds rapidly achieving a steady state voltage in approximately 4-5 cycles

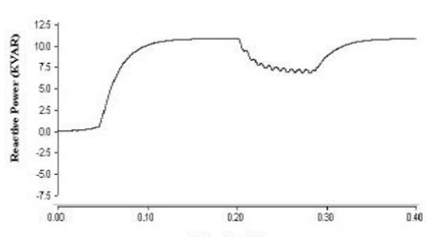

Fig.7: Transient response of PV solar system acting as a STATCOM.

VI STATCOM OVERVIEW:

The STATCOM is the shunt-connected reactive-power compensation device that is capable of generating. Power system [2].It is the witching converter capable of generating or absorbing independently controllable real and reactive power at its output terminals when it is fed from an energy source or energy storage device at its input terminals [6]. as shown in fig.8: Specifically, the STATCOM considered as a voltage source converter that, from a given input of dc voltage produces a set of 3-phase ac-output voltages, each in phase with and coupled to the corresponding ac system voltage through a relatively small reactance (which is provided by either an interface reactor or the leakage inductance of a coupling transformer). The dc voltage is provided by an energy-storage capacitor. The VSC has the same rate current capability when it operates with the Capacitive- or inductive-reactive current. Therefore, a VSC having certain MVA rating gives the STATCOM twice the dynamic range in MVAR (this also contributes to a compact design

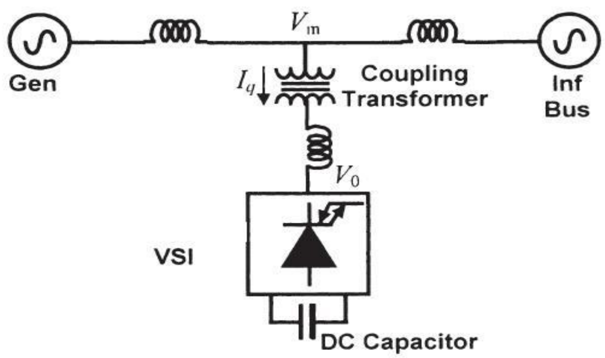

Fig.8: Single Line STATCOM Power Circuit

A. PRINCIPLE OF STATCOM:

A STATCOM is a controlled reactive source, which includes a Voltage Source Converter and a DC link capacitor connected in shunt, capable of generating and/or absorbing reactive power. The operating principles of STATCOM are based on the exact equivalence of the conventional rotating synchronous compensator

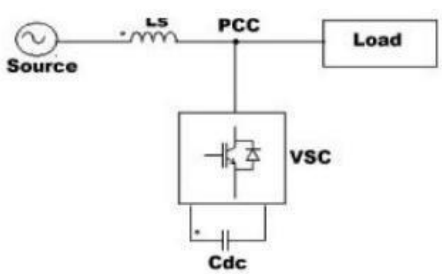

Fig.9: Circuit Diagram of STATCOM

The AC terminals of the VSC are connected to the Point of Common Coupling (PCC) through an inductance, which could be a filter inductance or the leakage inductance of the coupling transformer, as shown in Fig.9:The DC side of the converter is connected to a DC capacitor, which carries the input ripple current of the converter and is the main reactive energy storage element. This capacitor could be charged by a battery source, or could be recharged by the converter itself. If the output voltage of the VSC is equal to the AC terminal voltage, no reactive power is delivered to the system. If the output voltage is greater than the AC terminal voltage, the STATCOM is in the capacitive mode of operation and vice versa. The quantity of reactive power flow is proportional to the difference in the two voltages. For a STATCOM used for voltage regulation at the PCC, the compensation should be such that the supply currents should lead the supply voltages;

VII. Power Transfer Limits in Study System:

The Conventional Reactive Power, Control with Novel Damping Control. In this study, the solar DG is assumed to operate with its conventional reactive power controller and the DG operates at near unity power factor. The night time operation of solar (DG), the dc sources are disconnected, and the solar DG inverter is connected to grid using appropriate controllers, the stable of power transmission limits obtained from transient stability studies and the corresponding load. During night with conventional reactive Power Controllers. The maximum stable power output from the generator is (731MW), when the solar DG is simply sitting idle during night and is disconnected from the network. This power-flow level is chosen to the base value against which the improvements in power flow with different proposed controllers are compared .The real power from generator and that entering the infinite bus for this fault study are shown in Fig.10(a): The sending-end voltage at the generator is shown in Fig.10(b): which shows a voltage overshoot of 1.1p.u.SolaoperationDuringthenightwithdampingControllers

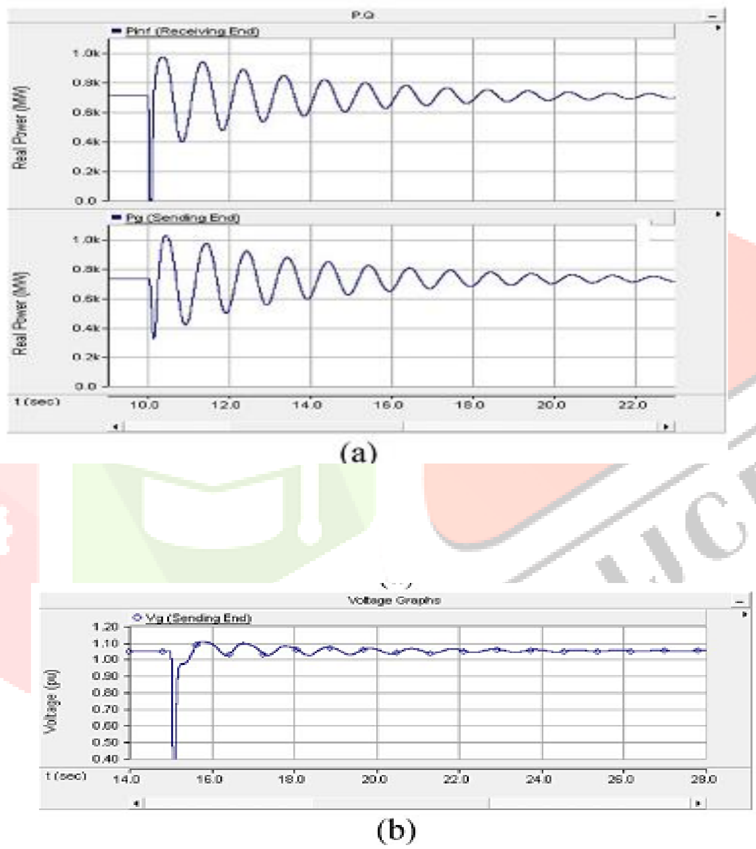

Fig.10 (a): Maximum. (b) Voltage at the generator terminal nighttimes power transfer (731 MW) from the generator when solar DG remains idle

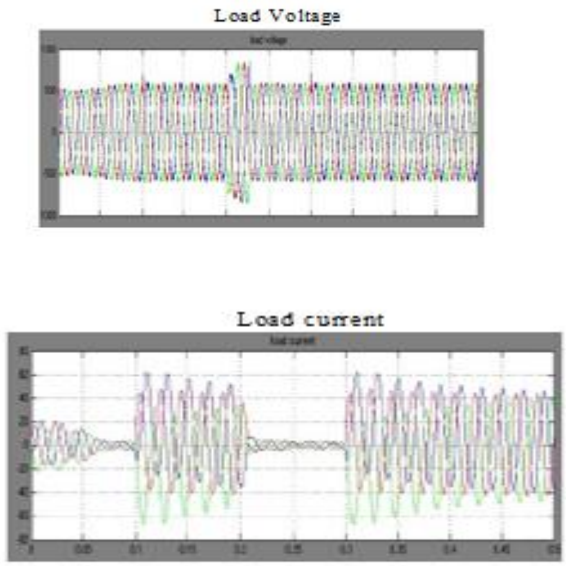

Fig.11: Load Voltage and Load current

Shows the load voltage and load current. When the system is disturbed at 0 to 0.1 and 0.2 to 0.3, the load voltage is remains constant

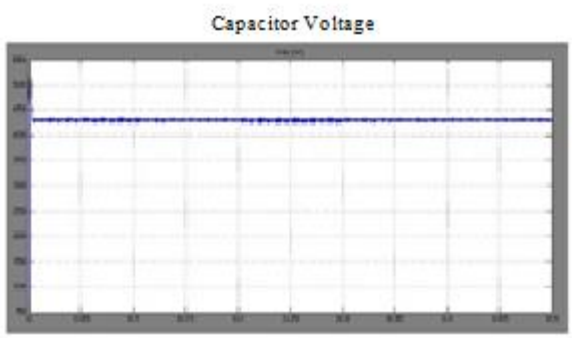

Fig.12: shows the voltage across the capacitor, at the initial stage the capacitor voltage is varied; it takes some time to settle.

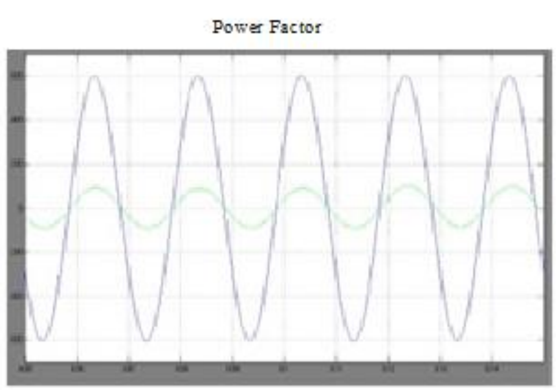

Fig.13: shows the power factor of the system with the STATCOM using PI controller.

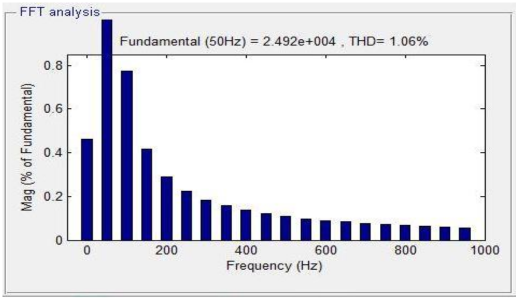

Fig.14: Spectrum analysis of the source current with STATCOM

shows the spectrum analysis of the power system with PI controlled STATCOM. The THD value is 1.06%

VIII. RESULT:

The simulation has been run on a MATLAB R2009a and laptop with Microsoft windows 7, processor: Intel® CORE™ i3.Simulation results are given here for non-linear load, and hybrid series active filter is used to mitigate harmonics generated by non-linear load. The supply is purely sinusoidal with phase to neutral RMS voltage i120volt and frequency 50Hz.

IX. NON-LINEAR LOAD:

Power transmission limits during night and day and Fig. 16 shows the FFT analysis of increasing grid power transmission limits during Simulation results are given here for non-linear load. Fig.9.1 shows the graphical representation of increasing grid night and day.

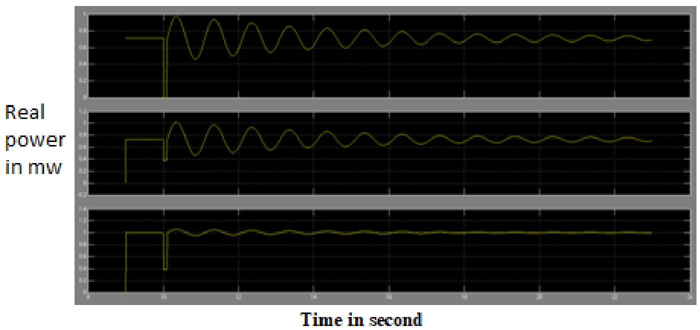

Fig.15: Source voltage and current before hybrid series active filter connection

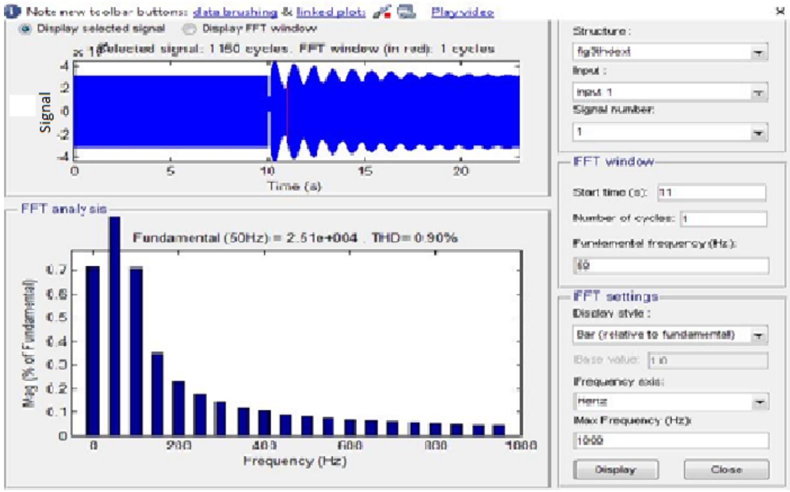

Fig.16: shows the FFT analysis of source voltage.

Shows the FFT analysis of source voltage It may be noted that, before filter connection, the source voltage waveform is Non-sinusoidal because of which its THD is as 1.06% and its fundamental value is 2.492e+004.

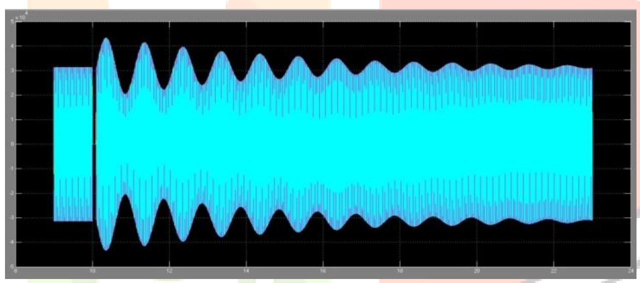

Fig.17: Load voltage and current after compensator connection.

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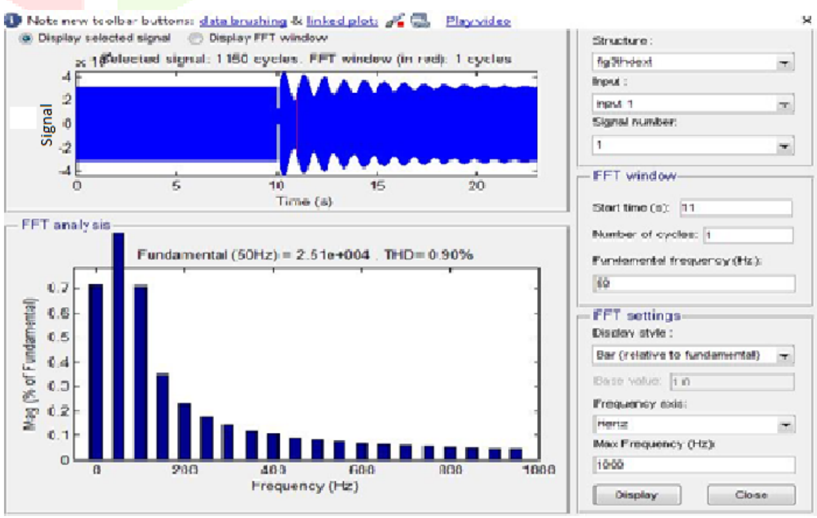

Fig.18: shows the FFT analysis of load voltage.

After filter connection the load voltage has a THD is 0.90% and its fundamental value is 2.51e+004.The fundamental value remains approximately the same when the filter is connected which prove that the filter injects only the harmonic voltage and the grid injects the fundamental component of the load voltage. PI helps in reducing total harmonic distortion and maintains it to acceptable level. PI helps in increasing grid power transmission limits during night and day

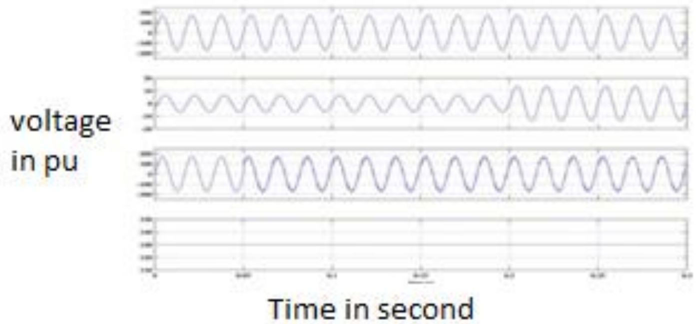

Fig.19: Series compensator to correct the power factor. For successful performance of reference voltage.

The reference voltage using instantaneous reactive power factor is presented in this paper. HSeAF helps in reducing total harmonic distortion and maintain it to acceptable level. The simulation results using MATLAB/Simulink verifies that and efficiently be used to control hybrid series active power filters. Thus, a more accurate and the faster transient response was achieved without compromising in the Compensation behavior of the system

X. CONCLUSION:

The normal solar plant remains idle when the sunlight is not good. and source inverter is a key component of the both solar plant and the (STATCOM), Hence the solar plant is used as STATCOM during dark periods to improve voltage regulation and the power factor. When, improved the power factor then load current will be reduces. It is also the system remains balanced with better efficiency and the less transmission losses. The Simulated distribution systems results are validate these points. Hence the power quality and electrical performance of the distribution system is improved

XI .REFERENCES:

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