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Efficient Control Strategy for Three Phase Multi Grid System using Hysteresis Current Control with Wind, PV and Fuel Cells

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Abstract-This work focus in modeling and simulation of Photovoltaic Wind Hybrid Electric Power Framework interconnected to the electrical utility, PV Wind and energy unit based REPS, considering all radiation, temperature, wind rates and variety of the heap request amid the day. A PC simulation program has been intended to reenact all amounts of REPS, for example, stage voltage of the inverter leg and current in each IGBT's for PV and WTG. It likewise mimics air conditioning yield current of the inverter that infused to the heap/matrix, stack current, lattice current, power output from PV and WTG, power conveyed to or from network lastly power factor of the inverter for PV, WTG and framework. The proposed PC simulation utilizes hysteresis current control and momentary p-q (real- imaginary) power hypothesis. The PC simulation program is affirmed on a sensible circuit show which executed in the Simulink condition of MATLAB and works as though ON-line. There are sure difficulties in the reconciliation of photovoltaic frameworks straightforwardly. The high entrance of Photovoltaic framework and appropriated generators requires imaginative making arrangements for the activity and the board of the power grid so as to continue or even to enhance the consistency and nature of power. The power electronic parts assume a fundamental role for synchronization of dispersed age to the current grid. In the present situation current controlled heartbeat width balanced voltage source inverters is broadly used to achieve the errand.

Keywords- wind and PV system, hysteresis current control, REPS.

I. INTRODUCTION

In the field of power electronic systems, permanent enhancements and especially improvements of semiconductor device properties have taken place. IGBTs as well as thyristor based technologies have received a lot of interest in industrial and energy supply applications. Within recent years, the state of the art two-level inverters have been replaced in some special applications. Inverter topologies like three-level inverters (solar energy) or modular multilevel inverted have increasingly come into operation. Solar three-level NPC inverters enable the possibility to reduce the size of passive components and thus to reduce costs. For HVDC applications high level systems were introduced to guarantee secure operations even under high voltages.

The outline of a microgrid which incorporates numerous frameworks: PV, a variable-speed wind generator, power module, micro turbine and a battery energy storage framework is appeared in. Each distributed energy asset is interfaced with its comparing transport through a power-electronic converter. The microgrid is associated with the upstream network at the Purpose of basic coupling (PCC). The power is outfitted from a Low-voltage (LV) transmission grid, through a substation transformer. The microgrid works with two modes: the grid-associated mode and the islanded mode. In the grid-associated mode, the PCC is shut and the microgrid is associated with the primary grid. It drives that the microgrid can trade energy with the principle grid. At the point when the upstream network happens the unsettling influence or the microgrid gets the ideal activity express, the switch at PCC can be opened to disengage the microgrid. Hence, the microgrid can keep on working in the supposed islanded mode.

The use of fossil fuel for production of power is accountable for increase of greenhouse gases. Day by day the emission label is seems to be increasing like a never ending process. Seeing the uncharacteristic changes in climate, an international joint effort is required to avoid the adverse consequences in an effective and economical way. For a country like India whose per capita consumption is increasing exponentially, the hunger for power cannot be fulfilled by the conventional sources while environmental issues are main concerned. Therefore, generation of power from green sources like PV System has become an essential part to conquer sustainability and reduce the consumption of fossil fuel.

Surprisingly, the basic control techniques have not changed significantly since the 1990s. Concepts based on Pulse-Width Modulation, Space Vector Modulation or Direct Tourque Control are established and basic modulation techniques for inverters in todays applications. Most of the mentioned modulation techniques generate inverter output voltages to control grid or motor currents or to act as activators. As the current is controlled indirectly using a PI-controller those methods are called indirect current control techniques within this work. The disadvantages of indirect current control methods are wellknown and subject of intense research in the last decades. Problems occur, for example, if the inverter interacts with non-linear unknown changing loads or operates near limits or under failure conditions.

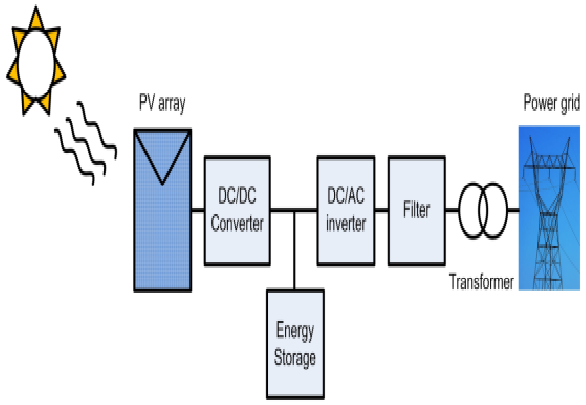

Fig. 1.1 Components of a Grid Connected PV System.

Several components are needed to construct a grid connected PV system to perform the power generation and conversion functions, as shown in figure 1.1. A PV array is used to convert the light from the sun into DC current and voltage. A DC converter is connected to the PV array to increase its terminal voltage and provide the means to implement an MPPT technique by controlling its switching duty cycle. The output power from the array is stored temporarily in large capacitors to hold power before DC/AC power conversion. A three phase inverter is then connected to perform the power conversion of the array output power into AC power suitable for injection into the grid. Pulse width modulation control is one of the techniques used to shape the magnitude and phase of the inverter output voltage. A harmonics filter is added after the inverter to reduce the harmonics in the output current which result from the power conversion process. An interfacing transformer is connected after the filter to step up the output AC voltage of the inverter to match the grid voltage level. Protection relays and circuit breakers are used to isolate the PV system when faults occur to prevent damage to the equipment if their ratings are exceeded.

II. CONTROL OF THREE PHASE GRID CONNECTED PV SYSTEM

First, the structure of the system and its control blocks are introduced. Then, the function of each block is examined in detail. An overview of the dq transformation and sinusoidal technique are presented for their importance in building the inverter control system. The boost DC converter is controlled using an open loop maximum power point tracking technique in order to achieve fast control response to transients and changes in weather conditions.

The system was studied under grid-side fault conditions to examine the effect of the transformer topology selection on the propagation of zero sequence currents to the grid. These currents can intervene with the correct operation of the utility protection relays.

The PV system under study is shown in figure 2.1. A photovoltaic array is used to convert sunlight into DC current. The output of the array is connected to a boost DC converter that is used to perform MPPT functions and increase the array terminal voltage to a higher value so it can be interfaced to the distribution system grid minimum kV. The DC converter controller is used to perform these two functions. A DC link capacitor is used after the DC converter and acts as a temporary power storage device to provide the voltage source inverter with a steady flow of power. The capacitor's voltage is regulated using a DC link controller that balances input and output powers of the capacitor. The voltage source inverter is controlled in the rotating dq frame to inject a controllable three phase AC current into the grid. To achieve unity power factor operation, current is injected in phase with the grid voltage. A phase locked loop (PLL) is used to lock on the grid frequency and provide a stable reference synchronization signal for the inverter control system, which works to minimize the error between the actual injected current and the reference current obtained from the DC link controller.

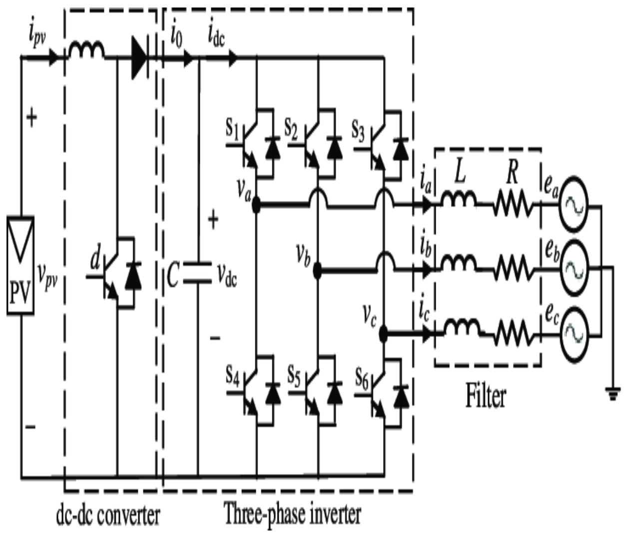

Fig 2.1 Grid Connected PV System Structure.

The current control strategy plays an important role in the development of shunt active filter. The hysteresis-band current control method is popularly used because of its simplicity in implementation.

Hysteresis current controller derives the switching signals of the inverter power switches in a manner that reduces the current error. The switches are controlled asynchronously to ramp the current through the inductor up and down so that it follows the reference. The current ramping up and down between two limits is illustrated in Figure 2.2. When the current through the inductor exceeds the upper hysteresis limit, a negative voltage is applied by the inverter to the inductor.

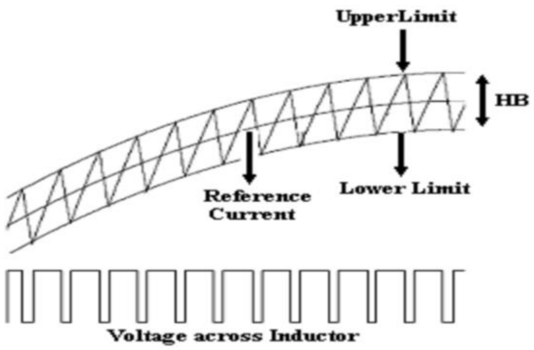

Fig 2.2 Hysteresis Current Control Operation Waveform

This causes the current through the inductor to decrease. Once the current reaches the lower hysteresis limit, a positive voltage is applied by the inverter through the inductor and this causes the current to increase and the cycle repeats. The current controllers of the three phases are designed to operate independently. They determine the switching signals to the respective phase of the inverter.

III. PROPOSED METHODOLOGY

A photovoltaic power framework is created to appraise the reference source current and exchanging design for VSC of microgrid. The square outline of proposed photovoltaic hybrid electric power framework is appeared in Fig. 3.1. It is notable that the REPS framework requires a customizable reactive power under fluctuating burden conditions to keep up the voltage at reference esteem. The proposed control never permits the expansion of DC interface voltage over the most extreme buoy charge voltage that builds the life of the battery. The proposed control mode based control utilized for power balance is found profoundly appropriate, steady and strong for such exceedingly nonlinear microgrid framework where the various parameters fluctuate in an expansive range. Fig 3.1 demonstrates the proposed model of three stage multi grid framework.

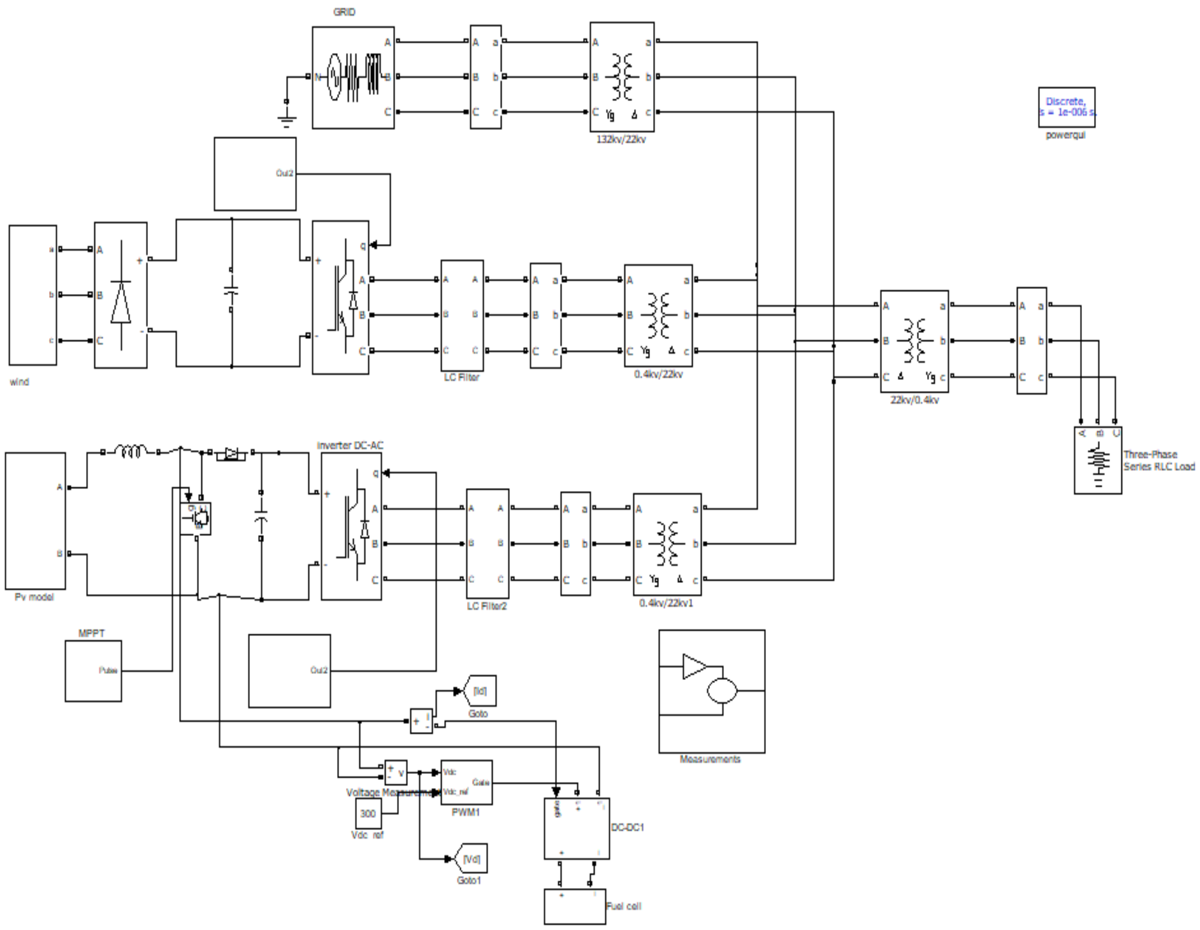

Fig. 3.1 SIMULINK Model of Proposed System

The disadvantages of variable exchanging frequency, substantial impedance between the stages in the event of three stage dynamic channel with separated impartial and inconsistency of the regulation heartbeat position. These downsides result in high current swells, acoustic commotion and trouble in structuring input channel. In a consistent frequency hysteresis current controller is proposed for control circuit applications.

In the IGBT proposed in this work, no physical band is included to restrain the expanding and diminishing the current. The IGBT The IGBT predicts the estimations of the two current signs, in particular, in the inverter, in light of the circuit parameters, to be specific coupling inductance, dc voltage, and quick criticism signs to decide the exchanging activities. fig. 4.2 show the control circuit of proposed system.

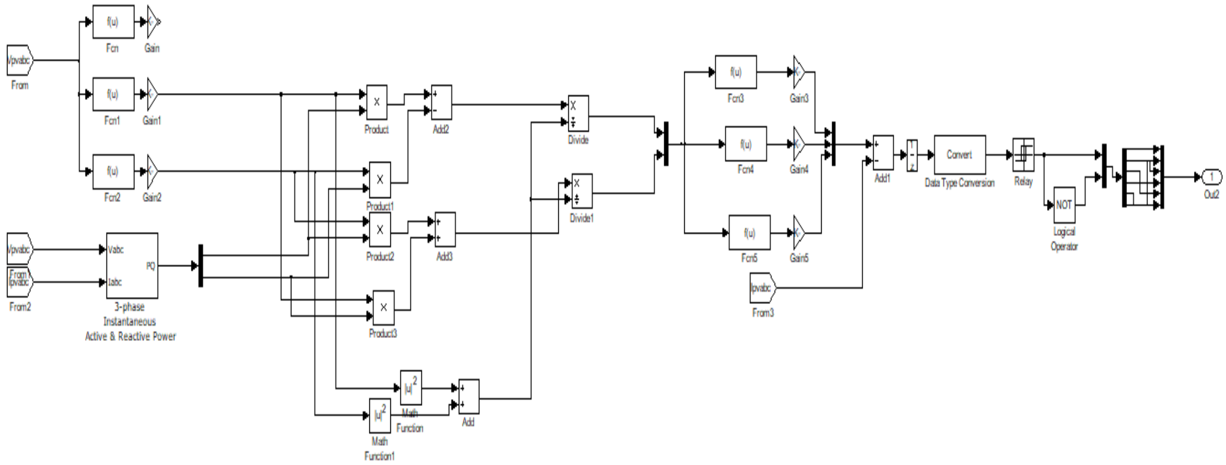

Fig.3.2 Simulink Model of Control Circuit of Proposed System

IV. SIMULATION RESULTS

The reenactment and test results for the three-stage grid-associated inverter are exhibited utilizing PV and WTG current controllers. The initial segment takes a gander at the inverter controlled utilizing a PV controller. Execution assessment of the controllers dependent on symphonious bending and dynamic reaction of the framework is likewise illustrated. The model contains the three-stage inverter powered from PV exhibit, with a LCL channel associated with the utility grid. The three-stage grid current is changed to reference casing and encouraged to the suitable controller. The control structure depends on grid PV or Hysteresis current control. The control procedures comprise of an outer voltage control circle and inner current control circle. This structure builds the execution of the control framework.

Figure 4.1 and Figure 4.2 show the three-phase grid voltage waveform and the three-phase current waveform. As can be seen from the figures, figure 4.1 represented the waveform of load power and load voltage . And figure 4.2 show the grid power and grid current.

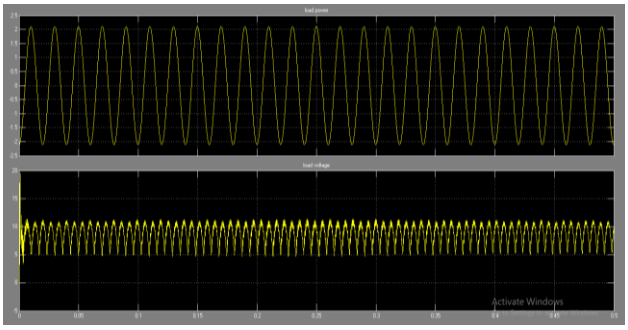

Fig. 4.1 Waveforms of Load Power and Load Voltage

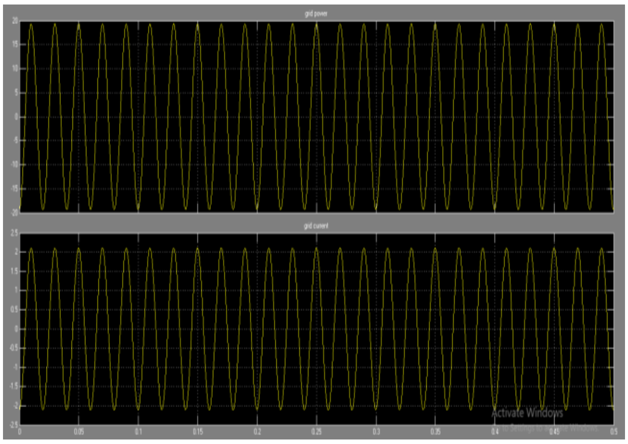

Fig. 4.2 Waveforms of Grid Power and Grid Current

Figure 4.3 and Figure 4.4 show the three-phase grid voltage waveform and the three-phase current waveform. As can be seen from the figures, figure 4.3 represented the waveform of hybrid voltage and hybrid current . And figure 4.4 show the grid power and hybrid power.

The examination obviously demonstrates that the hybrid power inverter is more favorable than the three stage frameworks. The focal points are better yield voltage of sinusoidal waveform, profoundly decreases bring down request sounds, substantially less grid power with expanded proficiency. The dimension can be expanded by growing the quantity of hybrid stages. Besides, the dimension is expanded by differing the estimation of info DC voltage which is named as new hybrid frameworks. From this discourse, it is presumed that the new hybrid inverter is superior to alternate kinds of staggered inverters on account of low THD esteem The trial yield waveform is less exact than the reproduction yield waveform.

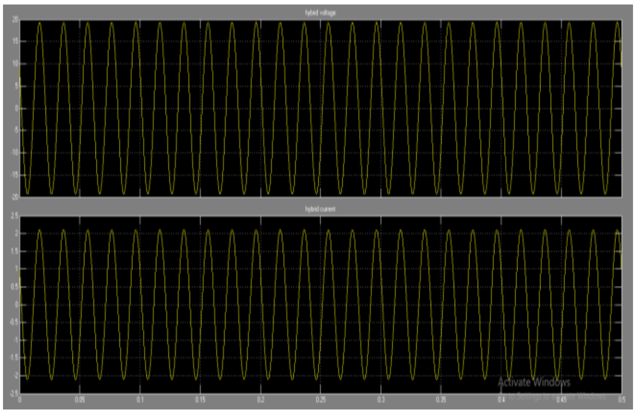

Fig. 4.3 Waveforms of Hybrid Voltage and Hybrid Current

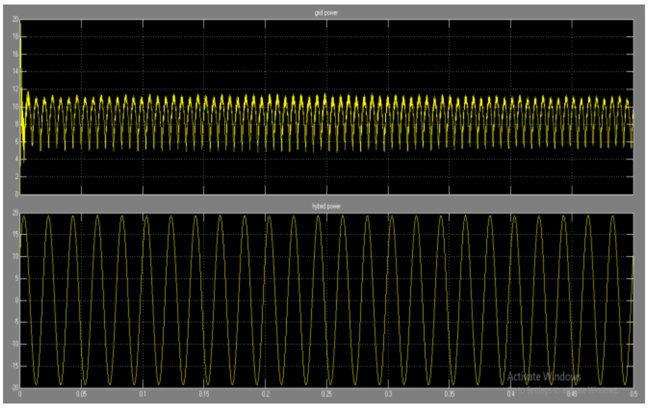

Fig.. 4.4 Waveforms Grid Power and Hybrid Power

The three-phase grid system has been controlled using PR current controller. Figure 4.5 and Figure 4.5 show the three-phase voltage and current waveform, respectively, for the inverter, obtained using the PR controller in steady-state. Using this approach, the PV controller with a harmonic compensator generates smoother waveforms in terms of the distortion. figure 4.5 represented the waveform of Fuel Cell Power and Fuel Cell Voltage. And figure 4.6 show the Waveforms Wind Power and Solar Power.

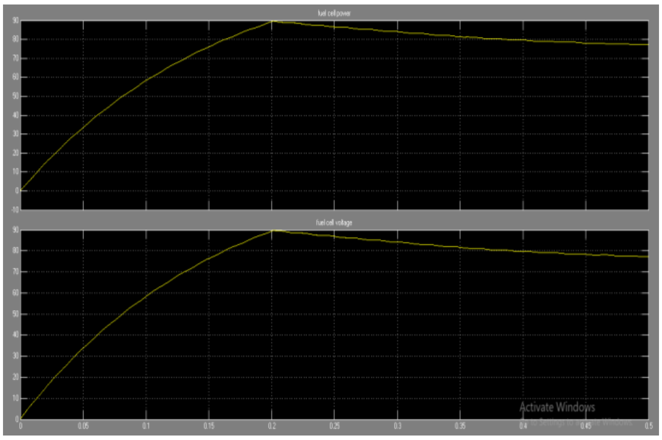

Fig. 4.5 Waveforms Fuel Cell Power and Fuel Cell Voltage

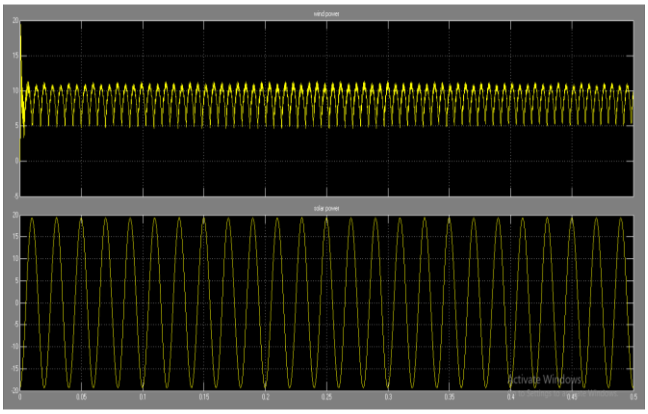

Fig. 4.6 Waveforms Wind Power and Solar Power

Be that as it may, a sudden change in the grid, for example, the drop or the expanded in the voltage could demonstrate an ascent with respect to the error between the reference flag and the controlled flag. This, thus, would apparently cause a recognizable difference from its ostensible incentive in the transient reaction. In such manner, the usage of the PV controller can't stay aware of the upsurge in the mistake, which debilitates the controller working. The stationary reference are appeared in Figure 4.7 and Figure 4.8, which represent the mistake between the reference and the deliberate current is decreases the 30% to 0%.

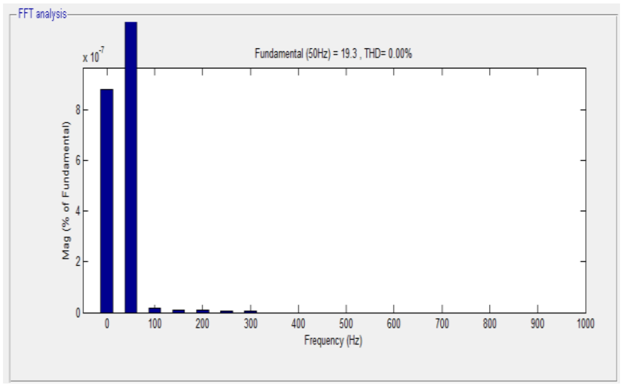

Fig. 4.7 Total Harmonic Distortion reduced from 30 % to 0%

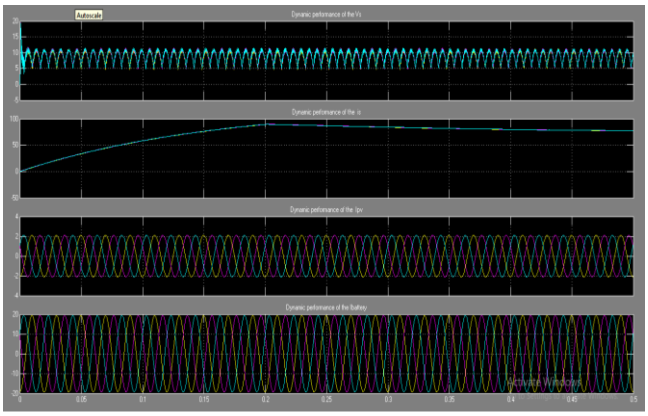

Fig. 4.8 Waveforms of Various Three Phase Quantities of Proposed System

V. CONCLUSION AND FUTURE SCOPE

Electric vitality request is expanded in everyday. Hybrid power age is the answer for repay the up and coming interest. This exploration work portrays the usefulness utilization of the multi grid gadgets to build the power quality execution of the power frameworks with an expansive offer of disseminated vitality assets, which incorporates huge sustainable sources, for example, Sunlight based, wind ranches and so forth. The new hybrid multi grid framework is utilized with the assistance of sustainable power source utility interface, for example, sun based board, wind vitality, the lead corrosive battery banks. Coordinate torque control can be utilized with the new hybrid H-connect staggered inverter to lessen the torque swells and enhance the execution of the acceptance engine drive. The exhibitions of different topologies of staggered inverters have been dissected in this examination work and the appropriateness to three phase multi grid framework with less THD.

The ideal position of PV controller gadgets might be examined in the pool display and additionally hybrid power showcase demonstrate in the rebuilt power framework. Man-made brainpower procedures may likewise be consolidated in the proposed framework to accomplish better execution. The power quality and voltage strength of substantial power frameworks with biomass disseminated vitality assets with various hybrid grid gadget must be examined. Voltage security of power frameworks with a substantial offer of dispersed vitality assets should be examined further alongside enhancement of hybrid gadgets area

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