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Performance of UPQC in Hybrid Renewable Energy Sources

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ABSTRACT: Unified Power Quality Controller (UPQC) has been proposed for power quality improvement in wind solar energy source. This work comprises of a phase wire UPQC, a LC filter. This hybrid approach significantly improves the performance of UPQC under unbalance source voltage condition. The UPQC adopted to compensate current and voltage-quality problems of sensitive loads and suppressing the load current harmonics under distorted supply conditions. The extensive simulation results have been carried out in MATLAB/Simulink environment power system block set toolboxes. From the results it has been shown that hybrid UPQC achieves superior capability of mitigating the effects of voltage sag/swell and suppressing the load current harmonics under distorted supply conditions.

KEYWORDS. Power quality, Hybrid Unified Power Quality Conditioner

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I.INTRODUCTION

Nowadays, as more sensitive loads, such as computers, automation equipments, communication equipments, medical equipments, and military equipments, have come into wide use, power quality has become a significant issue to both customers and the utility companies. Since these equipments are very sensitive in relation to input voltage disturbances, the inadequate operation or the fault of these loads brings about huge losses. The elimination or mitigation of disturbances propagated from the wind energy system is absolutely required to improve the operational reliability of these loads. According to these guidelines, the voltage sag or swell is allowed by 10%, the total harmonic distortion is allowed by 5%, and the voltage unbalance is allowed by 10%. UPQC has been widely studied in order to improve universal power quality by many researchers. The function of UPQC is to the disturbance that affects the performance of the critical load. The UPQC, which has inverters that share one dc link capacitor, can compensate the voltage sag and swell, the harmonic current and voltage, and control the power flow and voltage stability. However, the UPQC can compensate for the voltage interruption because it has energy storage in the DC link. In recent years, a number of schemes have been reported in literature for solving the power quality problems in distribution systems. In three single-phase inverters have been used to filter the source current harmonics and neutral current. This approach reduces the dc voltage requirement of the inverter but it requires a greater number of switching devices. Filtering of source current harmonics and neutral current. The UPQC has compensation capabilities for the harmonic current, the reactive power compensation, the voltage disturbances, and the power flow control. The control strategy is basically the way to generate reference signals of UPQC. The progress in power quality constituents like harmonic currents, voltage stability, voltage imbalance, voltage sag and swell by incorporating UPQC are exemplified clearly. The control technique for UPQC is implemented through controllers respectively.

II. UNIFIED POWER QUALITY CONTROLLER (UPQC)

Clarified that fault detection in transmission line has becoming a need of important, and increasing demand conditions UPQC The compensation effectiveness of the UPQC depends on its on its ability to follow with a minimum error and time delay to calculate the reference signals to compensate the distortions, unbalanced voltages or currents or any other undesirable condition. The star-connected transformer is connected in parallel to the load and a LC filter is connected between the neutral conductor of the utility and the neutral point of the star-connected transformer through a filter inductance. The single-phase LC filter produces the desired current for compensating source neutral current and injects the produced current through the neutral of the star- connected transformer. When star-connected transformer only acts as compensator then the transformer provides a low impedance path for the zero-sequence currents to flow

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between the load and the star-connected transformer. However, the effectiveness of the compensation is strongly dependent upon the location of the compensator and impedances of the star-connected transformer, and the system.

III. LITERATURE REVIEW

As The compensation effectiveness of the UPQC depends on its on its ability to follow with a minimum error and time delay to calculate the reference signals to compensate the distortions, unbalanced voltages or currents or any other undesirable condition. The star-connected transformer is connected in parallel to the load and a LC filter is connected between the neutral conductor of the utility and the neutral point of the star-connected transformer through a filter inductance. The single-phase LC filter produces the desired current for compensating source neutral current and injects the produced current through the neutral of the star- connected transformer. When star-connected transformer only acts as compensator then the transformer provides a low impedance path for the zero-sequence currents to flow between the load and the star-connected transformer. However, the effectiveness of the compensation is strongly dependent upon the location of the compensator and impedances of the star-connected transformer, and system.[1]

The eminence of power quality improvement in the integrated grid energy system with the solar photovoltaic (S PV) and wind energy (WE) hybridization using unified power quality controller (UPQC). The UPQC comprises of shunt active and series active power converters to enable the control schemes such as discrete 3 phase - phase locked loop (PLL) via a-b-c to d-q transformation and d-q to a-b-c transformation respectively. Subsequently, the system is subjected to the repeated disturbances in AC loads and output power gene rated from the renewable farm throughout the power transmission. Therefore, it is mandatory to overcome the foresaid issues by incorporating a variable re active power source. Apart from the regular application, UPQC is configured to look up the various concerns in connection to the quality of power such as diluting the harmonic current, voltage imbalance and reactive power compensation, sag and swell phenomena. The control technique for UPQC is implemented through the fuzzy logic controllers. The proposed UPQC al so helps in dropping the energy losses that happen in power systems components and also ensures the safety environment.[2]

The impose d novel idea is experimented through PSCAD simulation platform and the obtained results certainly justify the proposed UPQC for trapping the harmonic agents in the distributed renewable energy farms while exposed to non-linear/ susceptible load conditions. Variable renewable energy (VRE). Wind and solar photovoltaic (PV) do not naturally have on-site energy storage, so their output is typically referred to as non-dispatchable. Other characteristics that make VRE integration a challenge is the uncertainty associated with their output and asynchronous nature of interconnection to the grid. As costs for wind and solar continue to decrease and regulations require the use of more clean energy technologies, there is a need to understand the technical challenges and develop solutions to integrate ultra-high levels of VRE into electrical power systems. This paper defines ultra-high levels as VRE penetrations over 50% on an annual energy basis across a synchronous power system and up to 100% on an instantaneous basis. The annual penetration level is an average of the amount of energy the VRE produce (Wh) divided by the total amount of energy (Wh) needed for an entire year. Instantaneous penetration refers to the VRE power output (W) divided by the total power requirement (W) at any point in time. Instantaneous penetration can vary considerably during the course of a day depending on the available renewable resources and the electricity load.[3]

In non-isolated bidirectional DC-DC converters (NIBIDC), voltage output of buck/boost mode is incongruous at lower and higher end due to the existing gain. In this paper, a novel NIBIDC is designed in such a way that it enhances the gain in both buck and boost mode of operation. The proposed NIBIDC is employed with four power switches (MOSFET) with an anti-parallel diode embodied, four inductors and three capacitors used as passive elements. The current flow in parallel connected inductor improves the circuit competence. Voltage gain of NIBIDC in buck operation is lower than conventional cascaded bidirectional buck/boost converter (CCBBC) whereas the voltage gain is higher than CCBBC in boost mode. The switching stress is same while the efficiency of NIBIDC is more than CCBBC. The topology structure of the NIBIDC is simple and easy to control. The performance analysis under steady-state condition of the novel converter is carried out and a detailed comparison with CCBBC is done in connection to switching stress, converter efficiency and duty ratios to output power, etc. The operation details for proposed NIBIDC in both mode is verified/validated by experimenting with 20V input for different duty ratios in charging and discharging state of a battery and the results infer to be identical with theoretical analysis.[4]

The sun and wind-based generation are well thoroughly considered to be alternate source of green power generation which can mitigate the power demand issues. This paper introduces a standalone hybrid power generation system consisting of solar and permanent magnet synchronous generator (PMSG) wind power sources and an AC load. A supervisory control unit, designed to execute maximum power point tracking (MPPT), is introduced to maximize the simultaneous energy harvesting from overall power generation under different climatic conditions. Two contingencies

are considered and categorized according to the power generation from each energy source, and the load requirement. In PV system Perturb & Observe (P&O) algorithm is used as control logic for the Maximum Power Point Tracking (MPPT) controller and Hill Climb Search (HCS) algorithm is used as MPPT control logic for the Wind power system in order to maximizing the power generated. The Fuzzy logic control scheme of the inverter is intended to keep the load voltage and frequency of the AC supply at constant level regardless of progress in natural conditions and burden. A Simulink model of the proposed Hybrid system with the MPPT controlled Boost converters and Voltage regulated Inverter for stand-alone application is developed in MATLAB.
The dual active bridge (DAB) is apt bidirectional power converter for high power density applications. The power can be transferred via magnetic link stage and the waveform of flux distribution gets affected due to modulation control of DAB. Traditionally, the improved - Steinmetz equation is utilized to evaluate the core loss. However, this loss determination in the magnetic link is inaccurate due to modulation control of DAB converter. Moreover, in DAB converter, fixed core losses are taken into account for power transmission. In order to avoid these limitations, this paper presents accurate core loss estimation of magnetic links operated in non-sinusoidal excitation. Moreover, analyzed and presented design specifications, operation, test platform and experimental results. Finally, the measured output power of DAB converter has been compared with suitable analytic method, which concludes the proposed approach has minimum error margins.[5]

This proposes a novel reference signal generation method for the unified power quality conditioner (UPQC) adopted to compensate current and voltage-quality problems of sensitive loads. The UPQC consists of a shunt and series converter having a common dc link. The shunt converter eliminates current harmonics originating from the nonlinear load side and the series converter mitigates voltage sag/swell originating from the supply side. The developed controllers for shunt and series converters are based on an enhanced phase-locked loop and nonlinear adaptive filter. The dc link control strategy is based on the fuzzy-logic controller. A fast sag/swell detection method is also presented. The efficacy of the proposed system is tested through simulation studies using the Power System Computer Aided Design/Electromagnetic Transients dc analysis program. The proposed UPQC achieves superior capability of mitigating the effects of voltage sag/swell and suppressing the load current harmonics under distorted supply conditions.[6]

This paper describes a novel sliding mode method with the fuzzy controller approach in the development of unified power quality conditioner (UPQC) for reactive power, harmonics and both symmetric and asymmetric sag and swell compensation. The UPQC consists of both shunt and series converter having a common dc link. The shunt converter eliminates current harmonics generated from the nonlinear load and the series converter suppresses the voltage sag and swell generated from the supply side. The dc link control strategy is based on fuzzy-logic controller where as sliding mode controller is used in the inner current control loop to dictate the gate signals for switching of the both converters. To determine the efficiency of UPQC model, it is implemented through MATLAB. The simulation results show the superior capability of the proposed approach in mitigating the effects of current harmonics and voltage sag and swell generated from the supply side.[7]

Current unbalance is frequently encountered power quality problem. Negative sequence current leads to increase in machine temperature and unnecessary tripping of circuit breakers. Unequal phase current and harmonic current causes increased line losses and skin effect. In this paper, a new stationary reference frame control is proposed and implemented based on Positive and Negative Sequence Component Extraction. Positive sequence current is taken as reference for VSI, used as current unbalance compensator. VSI is designed to eliminate negative sequence current component thereby balance of currents are obtained. Consequently, reduction in lines losses and improvement of power factor is also observed in the power system.[8]

In this neural-network (NN)-controlled distribution static compensator (DSTATCOM) using a dSPACE processor is implemented for power quality improvement in a three-phase four-wire distribution system. A three-leg voltage-source-converter (VSC)-based DSTATCOM with a zig-zag transformer is used for the compensation of reactive power for voltage regulation or for power factor correction along with load balancing, elimination of harmonic currents, and neutral current compensation at the point of common coupling. The Adaline (adaptive linear element)-based NN is used to implement the control scheme of the VSC. This technique gives similar performance as that of other control techniques, but it is simple to implement and has a fast response and gives nearly zero phase shift. The zig-zag transformer is used for providing a path to the zero-sequence current in a three-phase four-wire distribution system. This reduces the complexity and also the cost of the DSTATCOM system. The performance of the proposed DSTATCOM system is validated through simulations using MATLAB software with its Simulink and Power System Block set toolboxes and hardware implementation.[9]

The dc link voltage of the Unified Power Quality Conditioner (UPQC) can significantly deviate from its reference during a transient event, caused by load connection/disconnection or/and supply side voltage sag/swell, though in the steady state the average dc link voltage is maintained at a certain preset level. During such transients, due to considerable dc link voltage deviation, the magnitude of the series injected voltage cannot be constant and this has an effect on the load voltage magnitude, which fluctuates. An improved sinusoidal pulse width modulation (PWM) voltage controller for the series compensator is proposed which adjusts continuously the amplitude modulation ratio in response to the dc link voltage deviations. Also, an adaptive dc link voltage controller is proposed which limits the dc link voltage deviation during transients and assures a negligible steady-state error. The effectiveness of the proposed control schemes is demonstrated through simulations.[10]

A discrete-time linear control strategy for a multi-level three-phase Unified Power Quality Conditioner (UPQC)based on Single-Phase Power Cells is presented. The multi-variable, non-linear, and coupled features of these topologies make the control strategy designs a difficult task. Controlling this kind of systems with single-variable linear controllers – as proposed in this work – presents significant advantages compared with other approaches as simplicity in the design steps due to the large number of tools developed for this kind of schemes. Particularly, a classic design method based on the Root Locus approach is used to choose the controllers parameters in order to achieve a given dynamical behavior. Compensation of reactive power and fundamental frequency disturbances is presented in this paper as part of a general control strategy for multi-level Active Power Filters. The proposed control strategy is implemented on the TMS320C6713 DSP based system for a low-power laboratory prototype and thus the controllers design is carried out on the discrete-time and -frequency domain. Also, due to the inherent asymmetries among the power cells in a modular topology, a dedicated local control strategy is proposed to ensure a symmetrical distribution of the power among the power cells. This feature allows the semiconductor devices of each module to operate under the same voltage and current ratings. Simulated and experimental results showing stationary and transient conditions demonstrate the feasibility of the control scheme.[11]

This presents the analysis and design of a 3-phase 4-leg (3P4L) unified series–parallel active filter (USPAF) with ultracapacitor energy storage (UCES) for improving the power quality in three-phase four-wire (3P4W) distribution system. The series and parallel active filter (AF) of 3P4L USPAF system are realized by four-leg voltage source inverters (VSIs) to a common dc-link capacitor. Due to its high-power density, the UCES is well-suited to supply high power for short period of time. The objective of this paper is to enhance the unbalanced voltage sag mitigating capability of the 3P4L USPAF system by adding UCES, directly connected in the dc-link. This is achieved by injecting energy from the UCES to maintain the dc-link voltage constant. Thus, the proposed system is capable of mitigating unbalanced voltage sag with zero-sequence component in the source voltage and compensating harmonic, reactive power and unbalanced current of the load in 3P4W distribution systems. The proposed scheme is validated by an experimental prototype with a 1.93 F UCES bank and using dSPACE DS1103 real-time control platform in the laboratory. The experimental results show that the combined system offer improved performance to maintain the load voltage constant at its rated value during unbalanced voltage sag in the supply voltage.[12]

Power quality problems have received a great attention nowadays because of their economical impacts on both utilities and customers. The current harmonics is the most common problem of power quality, while voltage sags are the most severe. This paper deals with a Unified Power Quality Conditioner for current and voltage perturbations compensation in a power distribution network. The topology is based on two 3-phase voltage source inverters acting respectively as a parallel active power filter and a series active power filter which share two DC link capacitors. The power flow, in the Unified Power Quality Conditioner system is analyzed. A novel hysteresis current and voltage control methods of Unified Power Quality Conditioner are studied with the aim to have robust control of the output voltage of series part and the output current of the parallel part. The DC voltage controller optimizes the energy storage of the DC capacitor where a fuzzy logic controller is developed. Simulation results are presented and discussed to verify the dynamical behavior of the Unified Power Quality Conditioner and to show the effectiveness of the used perturbation identification methods and hysteresis band adaptive controllers.[13]

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IV. PROPOSED SYSTEM

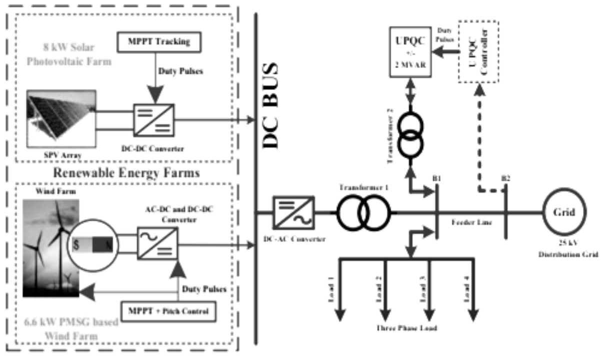
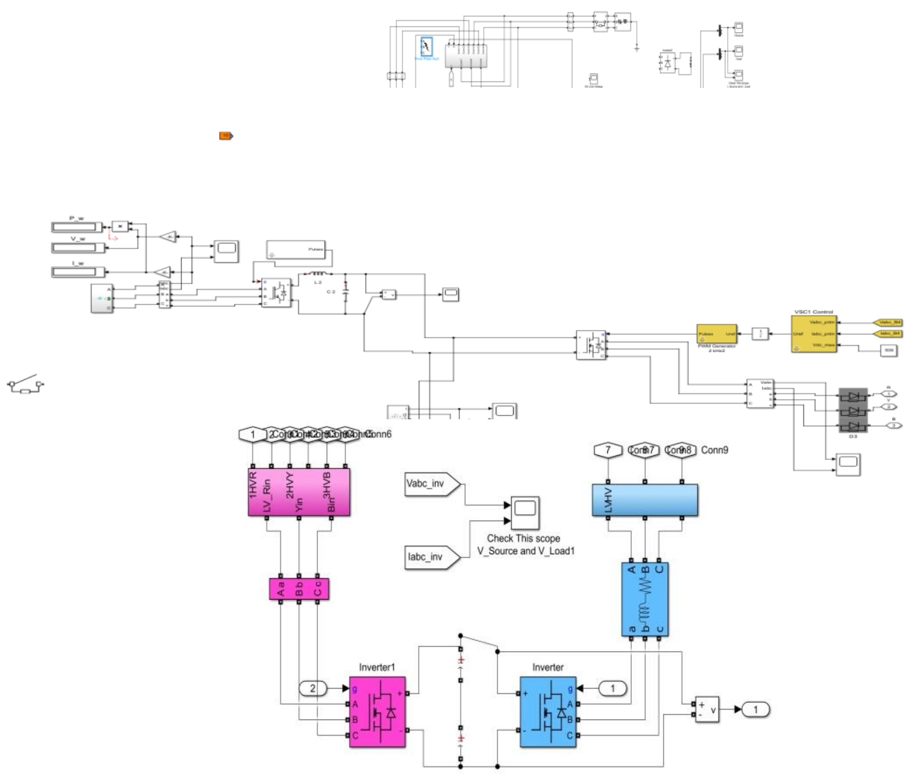


Fig 1. System Block Diagram

The pr ogress in power quality constituents like harmonic currents, voltage stability, voltage imbalance, voltage sag and swell by incorporating UPQC are exemplified clearly. The control technique for UPQC is implemented the progress in power quality constituents like harmonic currents, voltage stability, voltage imbalance, voltage sag and swell by incorporating UPQC are exemplified clearly.

UPQC is recognized as a multifunction power controller or common active power filter in the proposed electric power system UPQC is also used to balance the voltage disturbances caused by the power sources and certainly provides a fast dynamic response to the issues such as voltage sag, voltage swell, voltage fluctuations and offers volt ampere reactive support to the load components through the appropriate closed loop control. The design of UPQC comprises of two converters to resolve the foresaid issue and ensures the unity power factor at varying load conditions. Power quality improvement for the proposed hybrid renewable energy based distributed system using UPQC is realized through the MATLAB simulation environment.



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Power quality improvement for the proposed hybrid renewable energy based distributed system using UPQC is realized through the simulation environment. System is integrated in the renewable farm to supply the common DC bus. Inverter is interfaced between the DC bus and grid integrated AC transmission line. UPQC is connected to the transmission line between the grid and load respectively. Conversely, power quality issues like sag and swell are injected at the grid side. The proposed system is investigated under varying irradiance, wind speed and solar energy and reduce the harmonics in the system.

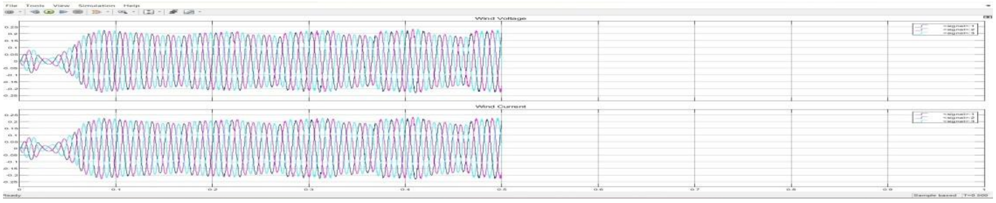

Fig 5. Voltage & Current of Wind Power Plant

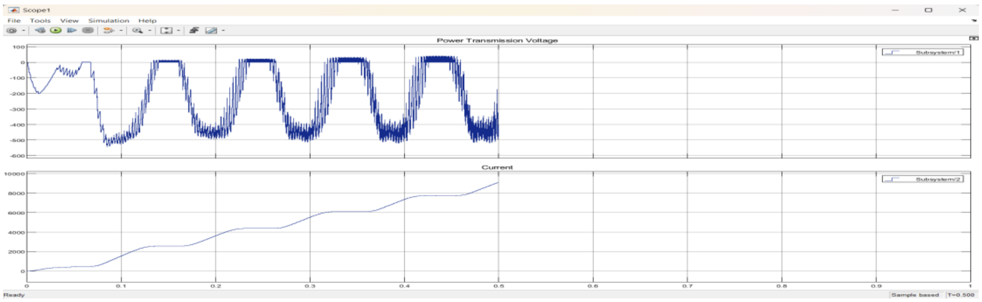

Fig 6. Output of Solar PV

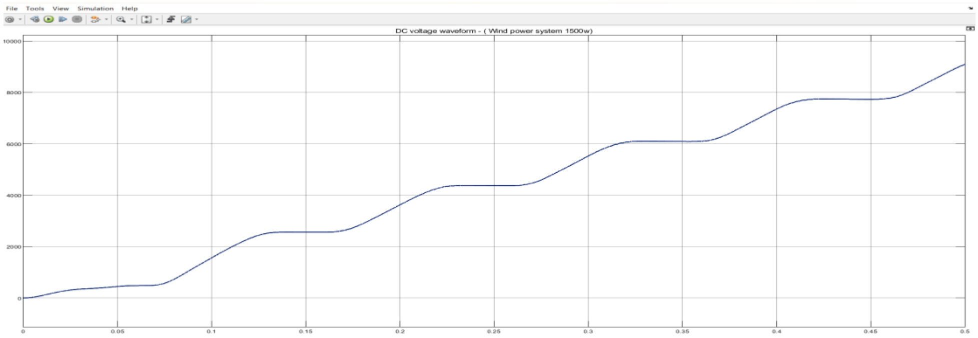

Fig. Wind Energy After Converting AC to DC

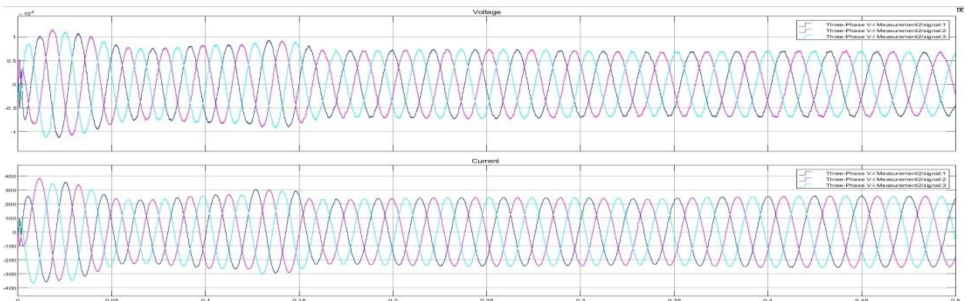

Fig 7. Voltage and Current across the Transformer

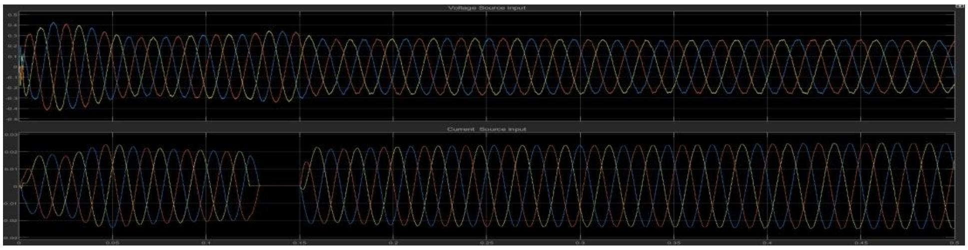

Fig 8. Voltage and Current across the Transformer before UPQC connected in Line

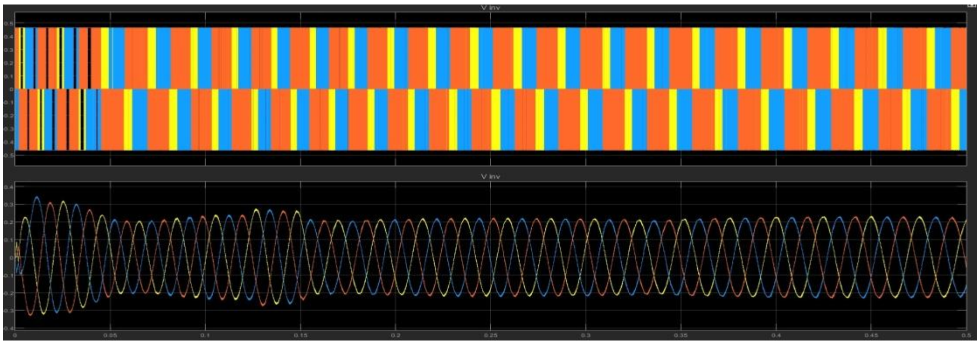

Fig 9. Inside UPQC

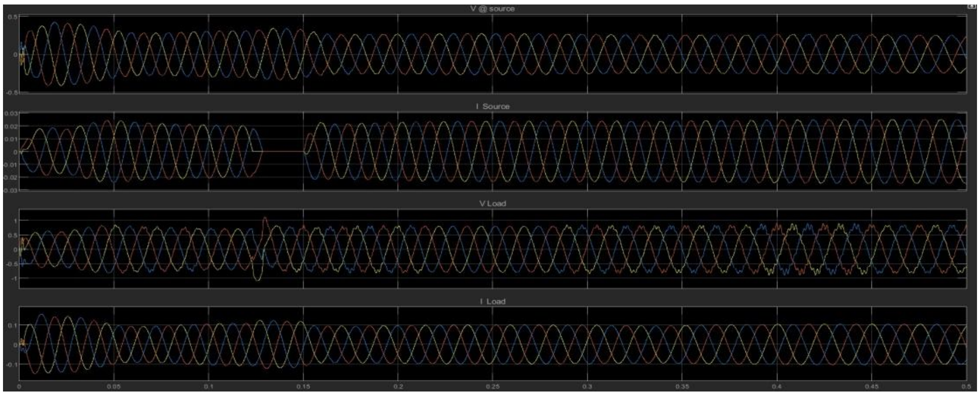

Fig 10. Output at Grid

VI. CONCULSION

The simulated waveforms showing the impact of sag and swell in the grid side parameters are controlled by UPQC more effectively in the proposed research. Finally, harmonic distortion in the proposed system is reduced to the permissible level. The simulated waveforms showing the impact of sag and swell in the grid side parameters are controlled by UPQC more effectively in the proposed research. Finally, harmonic distortion in the proposed system is reduced to the permissible level. enhancing the power quality in the hybrid renewable energy based distributed system using UPFC via fuzzy logic control. The system integrates SPV and WE in the renewable farm to supply the DC bus via respective converters and controllers. Modelling and analysis are performed with PPT execution to ensure the extraction of peak power from the SPV and WE systems. UPQC is inserted in the distributed system to enhance the power quality. Shunt and series converters are the elements of UPQC connected back-to-back with a DC link capacitor and it is controlled by abc to dq transformation techniques. Moreover, the elimination of harmonics occurring due to the nonlinear load is addressed clearly. The simulated waveforms showing the impact of sag and swell in the grid side parameters are controlled by UPQC more effectively in the proposed research. Finally, harmonic distortion in the proposed system is reduced to the permissible level.

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