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Performance Analysis of UPQC Architecture at Different Load Conditions

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Abstract: **The UPQC has the ability to improve the network quality at the installation site in electrical distribution networks or industrial electrical networks. The main objective of this thesis is to design a system to improve the network quality with a simplified architecture to support reactive power as well as to improve the active power available for load connections and to improve the efficiency of the system controls mentioned above. From this work, it was deduced that by developing and the inverter system with an control strategy in SVPWM, the device are proposed to improve the quality of the network can serve this goal with better results in the terms of performance and the efficiency. In this architecture can also be used in the hybrid systems, in making it more reliable. The designed system is also suitable for the delivery of different types of loads, such as non-linear load, symmetrical load, and asymmetrical load.**

Keywords: PCC, UPQC, PQ, DC.

I. Introduction

The UPQC has the ability to improve the network quality at the installation site on electrical distribution networks or industrial electrical networks. The UPQC should therefore be one of the most powerful solutions for large capacity loads sensitive to power supply voltage flickering / imbalance. The UPQC can be divided into two parts; and more precisely UPQC for a flicker / imbalance sensitive load installed by electricity consumers on their premises [1]. In UPQC, the active serial power filter | the supply voltage blinks/unbalances with the voltage across the load, forcing an existing passive shunt filter to absorb the current harmonics generated by a non-linear load. However, the suppression of the supply voltage flicker is accompanied by a low frequency fluctuation of the actual power input or output from the active series filter. As of the suggests name, are the combination of the series are series shunt filter are the active shunt filter and the series active filter.

II. Literature review

Anirudh Sharma et al. [1] In this paper, a control algorithm based on the theory of instantaneous symmetrical components (ISCT) for switching active power filters in series (SEAPF) is proposed. The series voltage provided by the SEAPF of effectively in controls the end-of-charge voltage against various voltage related problems such as sag, swelling and harmonics.

Pedro Melin et al. [2] This document presents a three-phase UPQC based in the current converters (CSC-UPQC), including guidelines for the design of key components, an appropriate control scheme and a selection process for the level. In particular, the transmission capacity criterion is used to set a minimum DC level so, that the CSC-UPQC to achieves of the same properties as a voltage converter-based UPQC with regards to compensation of voltage disturbances at the common coupling point.

N Khan et al. [3] this article presents the improvement of the network quality thanks to a UPQC on the load side. The proposed UPQC is the integration of shunts and series converters. The serial converter can compensate for voltage fluctuations in the AC power source due to an error. It can also be used to regulate voltage dips and under voltage situations. On the other hand, the shunt converter can compensate the current harmonics and improve the power factor.

B.Sasikala et al. [4] in this article are the presented are the new connection of UPQC and its improve of the PQ in the two branch of DS. UPQC are inline design to the specially for the VSC integration and the VSC shunt series to high quality power are provide and through compensation voltage drop, and the elimination of harmonic and the power factor network distribution power correction, so that the improve of power quality in MPP.

III. Objective

the main objective in this thesis are the follow are:

- Design of an inverter controlled by SPVWM which must be provided for an efficient power supply of loads of different types. Inverter control must be designed to improve system power. To do this, a spatial vector pulse width modulation technique was developed, which is then used to deliver pulses to the three-branch inverter.
- Design a network quality improvement system with a simplified architecture to support reactive power as well as improve the active power available to load connections.
- When designing the above controller, care must be taken to avoid sagging of the output voltage at the terminals as well as the available voltage at a load terminal.
- To improve the system efficiency using to controller and adopting in the different type of load, all reliable are function load.

IV. METHODOLOGY

MALAB/SIMULINK system are the develop model.

The model was developed in MALAB/SIMULINK environment. It's following of the main features:

- Scientific and technical informatics in high level language
- Desktop environment designed for the iterative exploration, system design, and the troubleshooting
- Charts to the visualize data and the tools to create custom charts
- Applications for curve fitting, signal analysis, data classification, control systems tuning and the many other tasks
- Complementary toolkit for a wide variety of the technical and the scientific applications
- Tools for creating applications with the custom user interfaces
- Royalty-free implementation options to share MATLAB programs with end users

A dual voltage inverter system is modeled and can power the load with solar or wind resources depending on availability, making the system more reliable.

The modeling of the different parts of the system was discussed in more detail. We discussed the photovoltaic system modeled with MPPT technology for its optimal operation, PMSG (Permanent Magnet Synchronous Generator) in relation to the wind turbine.

The VSI is the designed to drive of the mixed loads. The system of was DC storage capacitor model accordance by VSI.

These are network connected to the PCC and provide a non-linear and asymmetrical load. The VSI supplies in the available of the power to the DER in network. The DC source can DER or an AC source by the rectifier coupled in the DC intermediate a circuit.

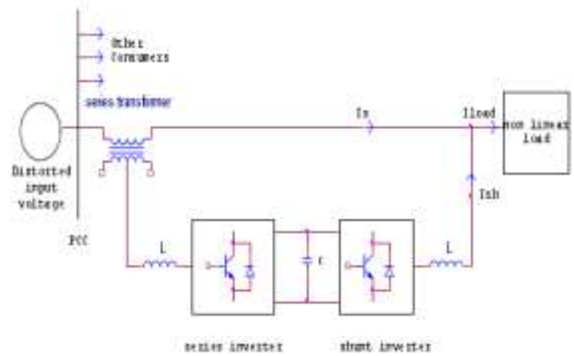

Fig. 1 proposed PQ compensation with load circuit diagram

1) Vector Modulation

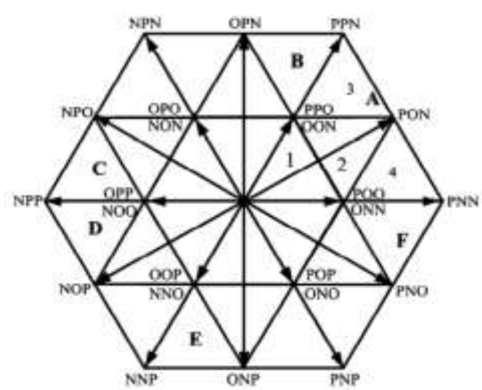

Fig. 2 Space-vector diagram of the three-level converter

Instantaneous voltage value in assuming are three-phase sine wave is the respectively are:

$U_a = V_m \text{Sin}\,(wt)$

$U_b = V_m \text{Sin}\,(wt - 2\pi/3)$

$U_c = V_m \text{Sin}\,(wt + 2\pi/3)$

The angle rotating and magnitude can be found is:

$$\begin{bmatrix} V_\alpha \\ V_\beta \end{bmatrix} = 2/3 \begin{bmatrix} 1 & -1/2 & -1/2 \\ 0 & \sqrt{3}/2 & -\sqrt{3}/2 \end{bmatrix} \begin{bmatrix} U_a \\ U_b \\ U_c \end{bmatrix}$$

$$\overrightarrow{V_{ref}} = V_\alpha + jV_\beta = {}^2/_3\,(U_a + aU_b + a^2 U_c)$$

Where

$$a = e^{j2\pi/3}$$

$$|\overrightarrow{V_{ref}}| = \sqrt{{V_\alpha}^2 + {V_\beta}^2} \quad , \theta = \tan^{-1}(V_\beta / V_\alpha)$$

The main idea of the simplified algorithm is to realize the computational flow based on only one sector instead of six as shown in figure 3, simply by knowing the relationships in the residence time calculations and the arrangement of the switches between the first sectors and the others as explained right away:

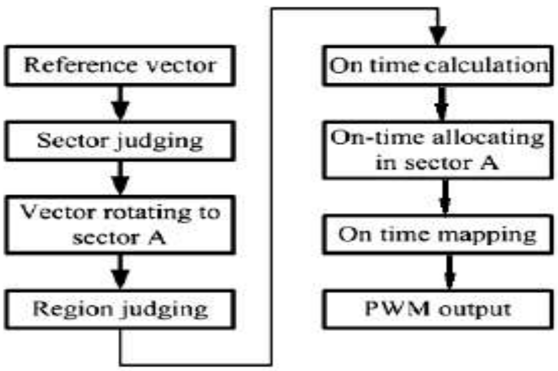

Fig. 3 SVPWM Simplified for the three level calculation flow

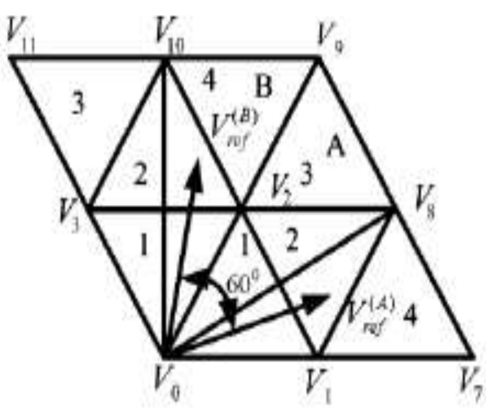

Fig. 4. Sector A and sector B 60^0 shifting

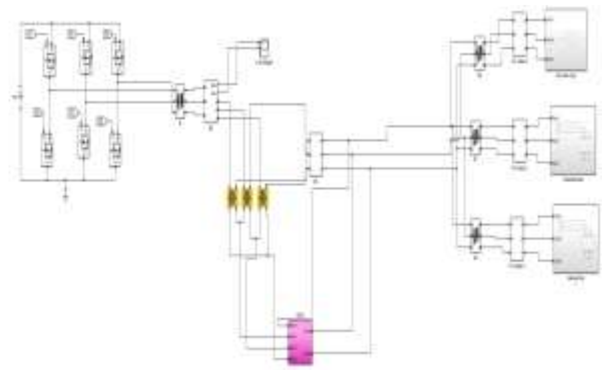

Fig. 5 Use UPQC in three level system simulation

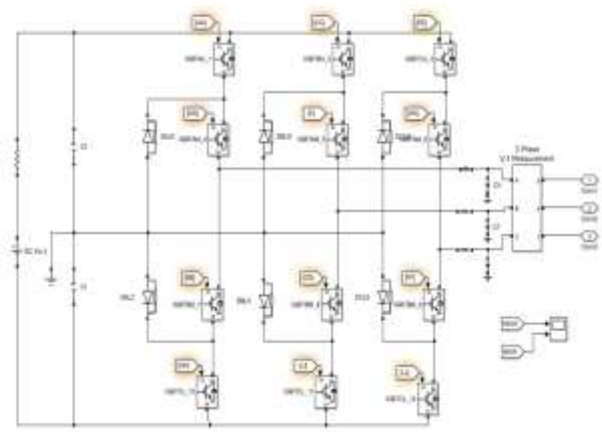

Fig. 6 PQ enhance in MATLAB architecture

V. RESULTS

The controller used was developed with 12 IGBTs with specially developed pulses that are turned on each of them for the their operations. We get the following results, which are combined in both cases:

Study 1: System without enhancement of Power quality.

Study 2: System with enhancement Power quality in device.

Study 3: two systems in load analysis.

In the better solution the in this method for linear and the nonlinear load of the system. In the relationship of the amplitudes in the active power and the reactive power oscillation, which result from asymmetrical ratios of the line voltages, has been obtained.

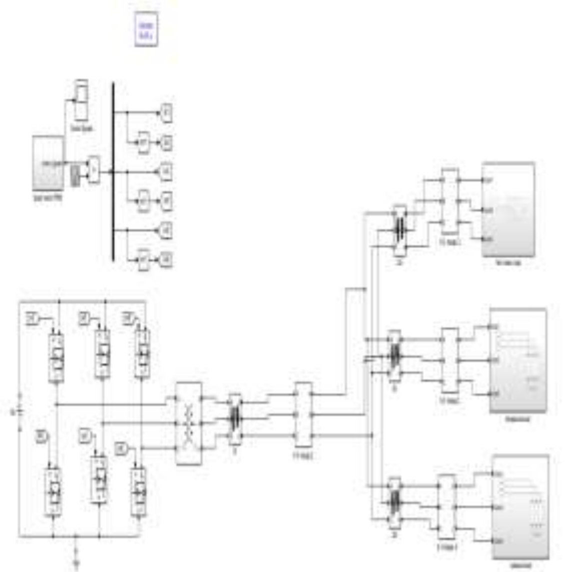

Fig. 7 system driving loads MATLAB/SIMULINK model in study 1

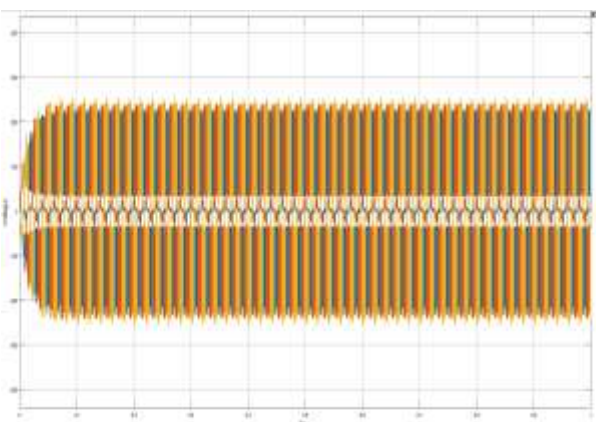

Fig. 8 system output Voltage from system in study 1

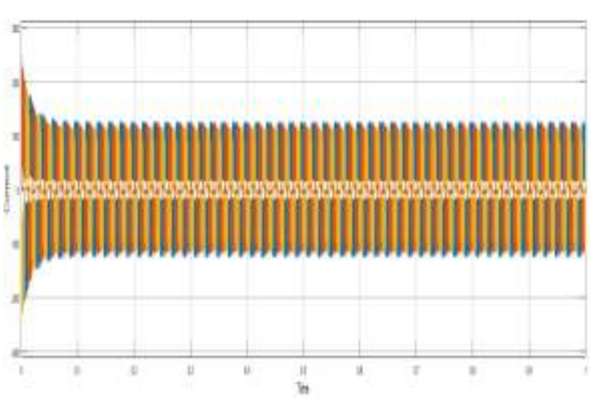

Fig. 9 system output current in study 1

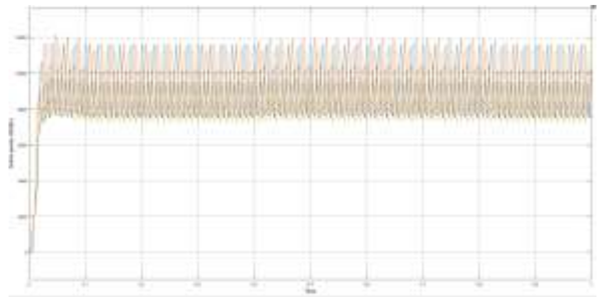

Fig. 10 system Active power output from system in study 1

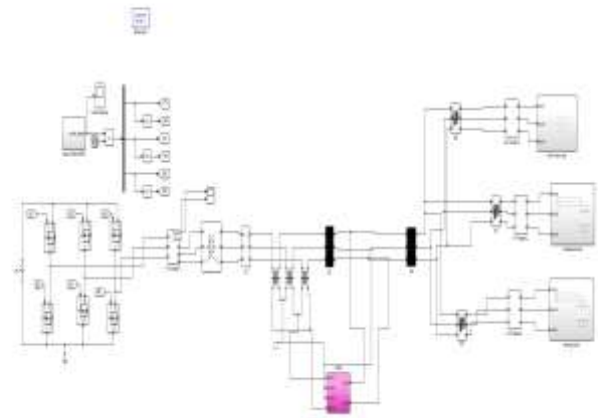

Fig. 11 system driving loads MATLAB/SIMULINK model in study 2

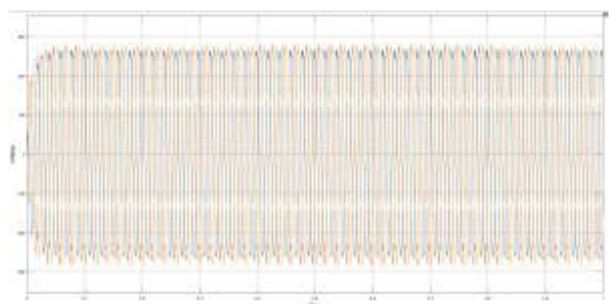

Fig. 12 system output voltage output from system in study 2

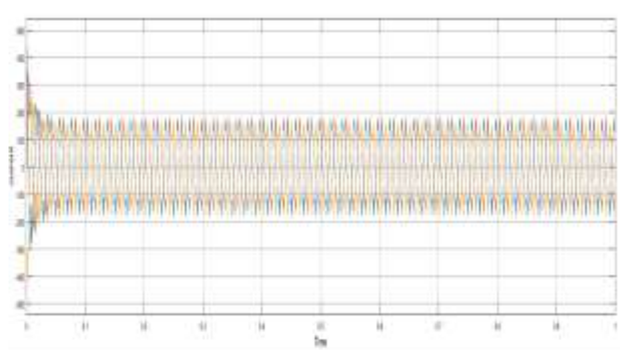

Fig. 13 system output current from system in study 2

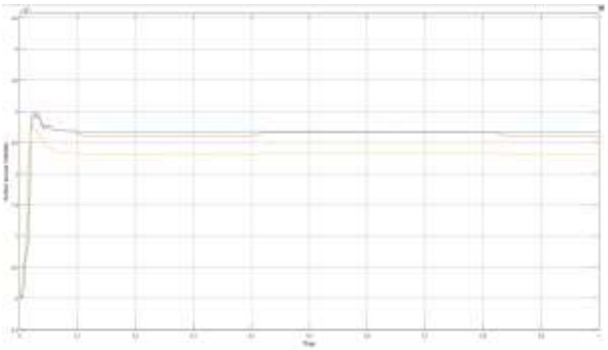

Fig. 14 System Active Power output from system in study 2

1) Two systems in load analysis

a) System load with Nonlinear

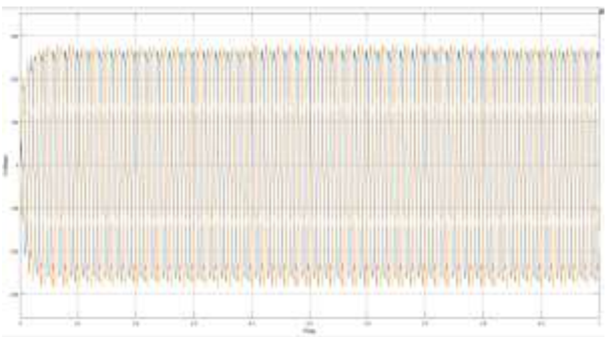

Fig. 15 system output voltage output with enhancement power

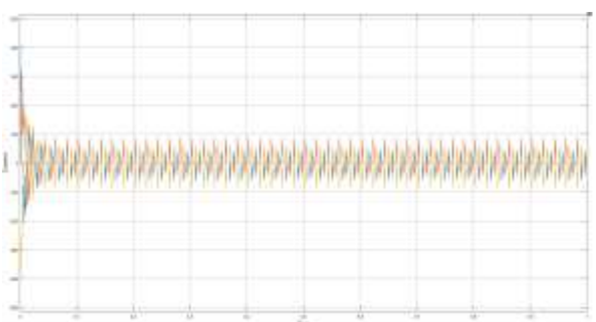

Fig. 16 system output current with enhancement power

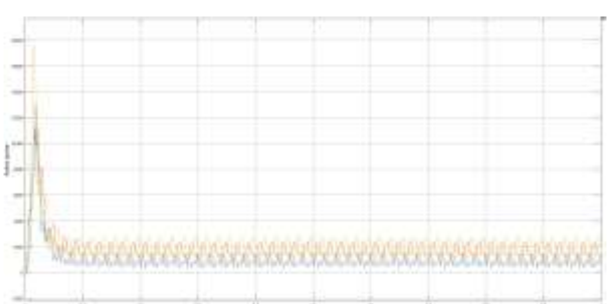

Fig. 17 system active power output with enhancement power

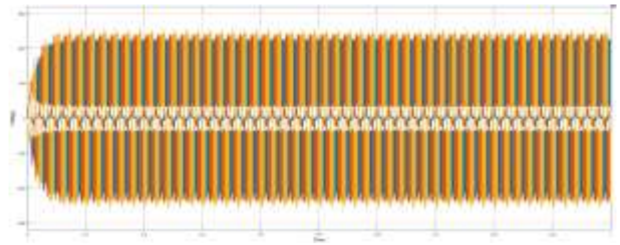

Fig. 18 system output voltage without enhancement power

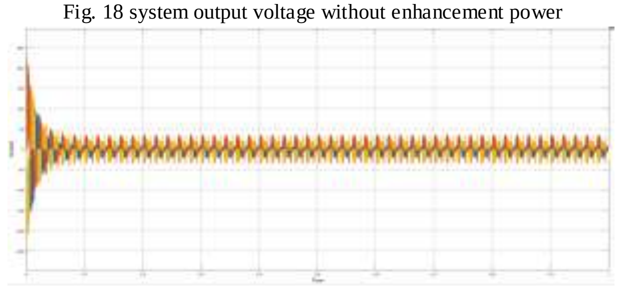

Fig. 19 system current output without enhancement power

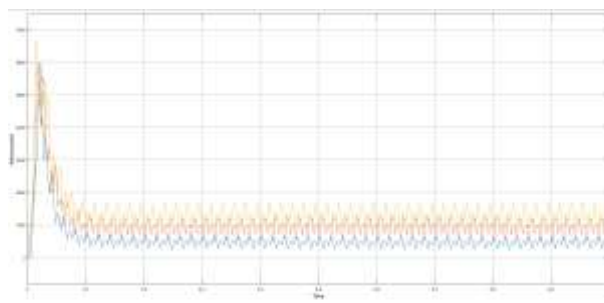

Fig. 20 system active power output without enhancement power

b) With Unbalanced load

Fig. 21 system output voltage output without enhancement power

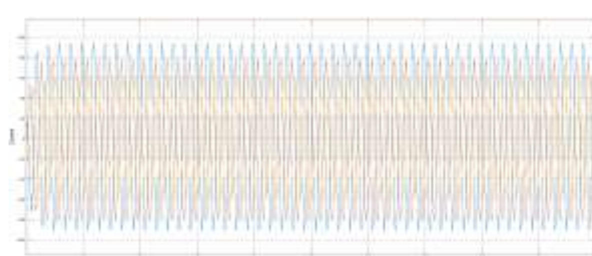

Fig. 22 system output current without enhancement power

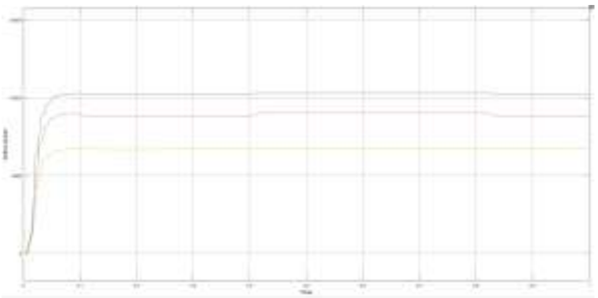

Fig. 23 system active power output without enhancement power

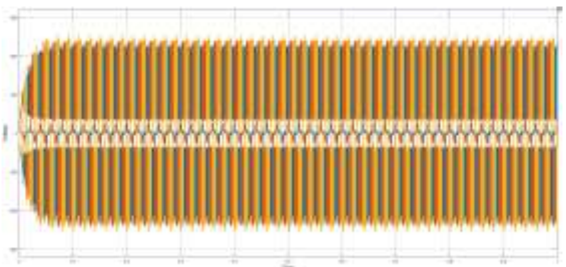

Fig. 24 system output voltage without enhancement power

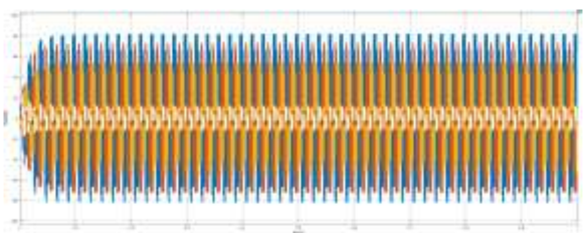

Fig. 25 system output current without enhancement power

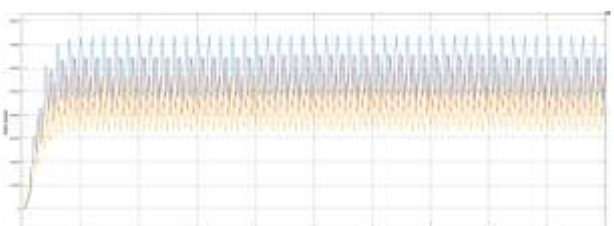

Fig. 26 system active power output without enhancement power

c) With Balanced load

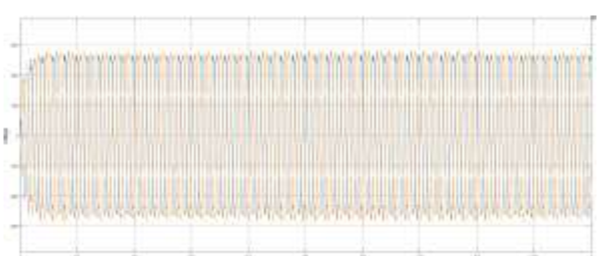

Fig. 27 system output voltage with enhancement power

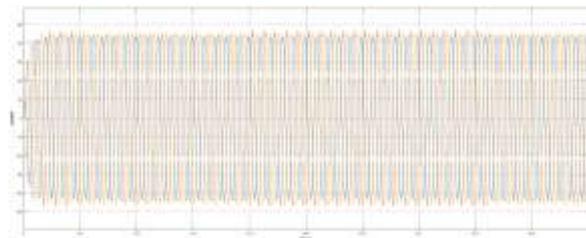

Fig. 28 system output current with enhancement power

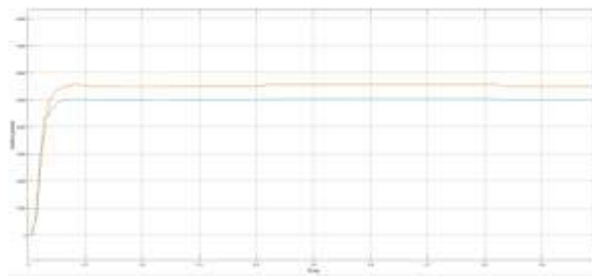

Fig. 29 System active power output with enhancement power

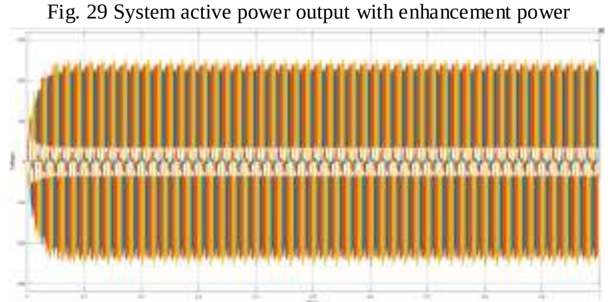

Fig. 30 system output voltage without enhancement power

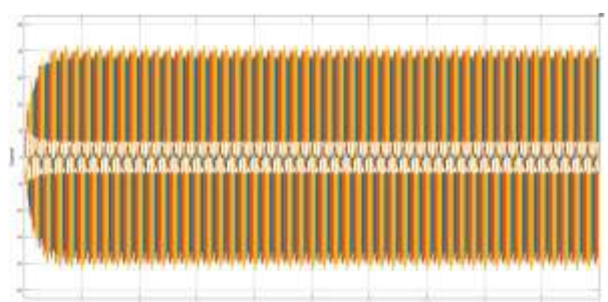

Fig. 31 system output current without enhancement power

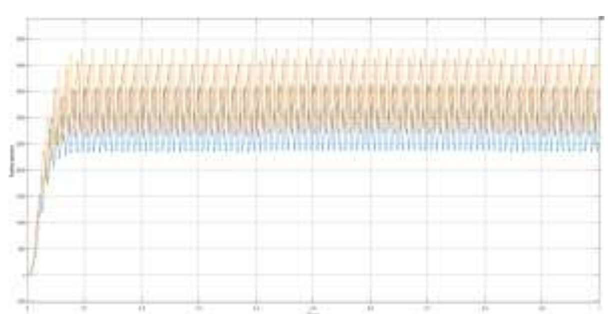

Fig. 32 system output active power with enhancement power

VI. VALIDATION

In this work, the performance was improved by using a device to improve the quality of the system performance. The systems are designed to drive various types of loads, non-linear, asymmetrical and symmetrical loads. The inverter is powered by SPWM modulation technology. It explains the improvement of the system's output power, which is then supplied to consumers. The device for improving power quality is performed using a diode and an IGBBT bridge circuit.

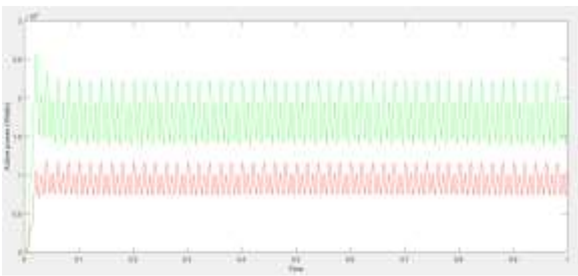

Fig. 33 system power Outputs of system to be the fed load

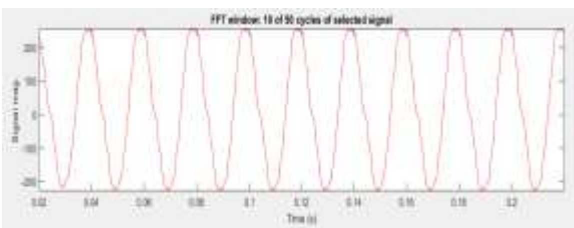

Fig. 34 system output in FFT analysis of system having enhancement of PQ

VII. CONCLUSION

to solve in order of the influence of mixed non-linear and unbalanced loads on the voltage output of the micro source inverters in the microgrid, this article proposes a comprehensive strategy that can be used for precise energy distribution, as well as a device for improving quality of power to increase the output power available to the load without changing the voltage level at the load connection.

Here in this work, we designed an SVPWM technology controlled inverter with the network quality improvement system and modified MATLAB / SIMULINK with architecture and it used to different load of the drive.

In addition, two models were created that offered an inverter system model that drives mixed loads as well as a device for improving the quality of the network. The following main conclusions were drawn from the results.

- Comparing the active output power of the system without the UPQC controller with the device proposed to improve the quality of the network with modified of the architecture, it was the found that the proposed of system provides 29 KW of power, which is considerably 27.5 KW higher than of the system without the device. The percentage increase is 5%, approximately.
- The system output power of load connection have also has been improved, to making of the system increasingly of reliable.
- The level of the output voltage is kept constant during the activation of the loads.
- The UPQC has compensated for mains voltage quality problems such as dips / bulges, asymmetry, flickering, harmonics, etc.

Therefore, from this work, it can be inferred that when designing an inverter with a control strategy of SVPWM, the proposed improvement power quality of the device can serve the purpose with better performance and the efficiency of results. This architecture can also be used in hybrid systems, making it more reliable. The designed system is also suitable for providing various types of load such as non-linear load, symmetrical load and asymmetrical load.

VIII. FUTURE SCOPE

The installation of inverter of system with a hybrid system in solar grid will be very successful indeed as it will reduce the dependence on the grid system. In other word is the system of green energy promote in which are the important energy source in every day running out. Therefore, people need to be looking for new renewable sources and solar energy is certainly one of the best options for this purpose. In future work, adaptive control based on a neural network will be designed for better network quality Three-phase networks with integrated non-linear and linear loads. The planned control scheme regulates the system voltage and improves the network quality very efficiently.

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