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An innovative transformer-free reboost converter and grid-connected inverter for a PV system

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ABSTRACT

This paper introduced An Innovative Transformer free reboost converter and grid connected inverter for a PV system. The PV array can be directly connected to the Reboost converte and proposed grid-connected inverter closed loop PID and Hysteresis controlled systems. The proposed grid-connected power converter consists of a dc–dc power converter and a dc–ac inverter. The salient features of the proposed power converter are that some power electronic switches are simultaneously used in both the dc–dc power converter and dc–ac inverter, and only two power electronic switches operate at high switching frequency at the same time (one is in the dc–dc power converter and the other is in the dc–ac inverter). The leakage current of the photovoltaic generation system is reduced because the negative terminal of the solar cell array is connected directly to the ground. The circuit will be simulated using MATLAB Simulink

KEYWORDS: Renewable Energy Sources1, Reboost converter2, Power converter3

1. INTRODUCTION

Three dominant factors are impacting the future electric systems of the world; government policies, efficiency need of the consumer, and the introduction of new intelligent computer and hardware technologies. In addition, environmental concerns have created governmental policies around the world, including at the federal and state levels, which are driving the entire energy system to efficiency, conservation, and renewable sources of electricity.

These factors are the main drivers that are expanding the use of all sorts of new renewable energy and storage technologies on the one hand and new energy efficiency and conservation techniques on the other. Consumers are becomingin the energy consumption decisions affecting their day-to-day lives. At the same time, they are expanding their energy needs. For example, consumer participation will ultimately include extensive use of electric vehicles (both cars and trucks), remote control of in-home appliances to promote energy conservation, ownership of distributed generation from ever more renewable energy sources, and management of electricity storage to locally match supply to demand.

The availability of new technologies such as more abundant and aware SCADA sensors, secure 2-way communications, integrated data management, and intelligent, autonomous controllers has opened up opportunities that did not exist even a decade ago. The electric energy system of the future needs to address all these needs and concerns by using advanced technologies to create a smarter, more efficient and sustainable grid. During recent years, there have been numerous articles and conferences about the Smart Grid, but much confusion remains among all constituencies about just what the term entails.

Although many different definitions have been proposed for the Smart Grid, in most cases the users have chosen particularly focused definitions related to their specific applications and local needs. Below, we define the Smart Grid in its broadest global terms. We begin with a description of the makeup of the present conventional electric energy system, and we then identify the areas that must change in order to provide the intelligence and control necessary to convert to the safe, secure, and efficient Smart Grid of the future. Papers that follow in this Special Issue give a cross-section through this vast new enterprise, and while not meant to be all-inclusive, are meant to be illustrative of the changes coming to the Smart Grid.

2. REBOOST TOPOLOGY

The Re-boost-topology is not the same as the coordinated boost-fly-back converter dependent on the association purpose of the siphon diode. By including an extra charge pump-circuit in series- with the-yield, the converter-accomplishes-ceaseless-info current& higher-voltage-gain while diminishing the voltage-stress for the principle-gadget & yield-diode in Figure 1.

This topology has the benefits of persistent input-current and even lower voltage-stresses when contrasted with the Re-boost-converter. The framework setup of the proposed converter showed in Figure 2.1. This Re-boost topology consists of six sections where as dc input, essential side circuit which consists of inductor L1 and transistor Q, , a regenerative snubber system, filter circuit which consists of C1,L2,D1,D2 and C2 components, and feedback control part. The significant image portrayals are outlined as pursues. VIN& II information input voltage & current, CIN is an information channel-capacitor. L1& L2 speak to singular inductors in the essential & auxiliary-sides of the CI (Coupled-Inductors), individually. Q is a switch and TQ is a firing control circuit. In the essential side circuit signifies a clamped capacitor (C1), a cinched diode (D1), & rectifier diode (D2) in the in re-generative Snubber system .The yield diode (Do) & the channel capacitor (Co) in the channel circuit. The characteristic of the novel proposed elevated step up system are exemplified in Fig-1 and in Fig-2 demonstrates the different modes in one switching operation & the detailed operation stages are depicted.

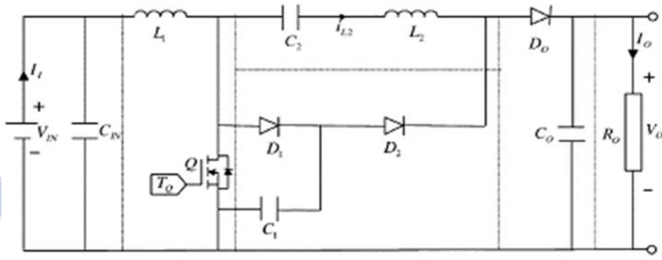

Fig 1 Re Boost System Configuration

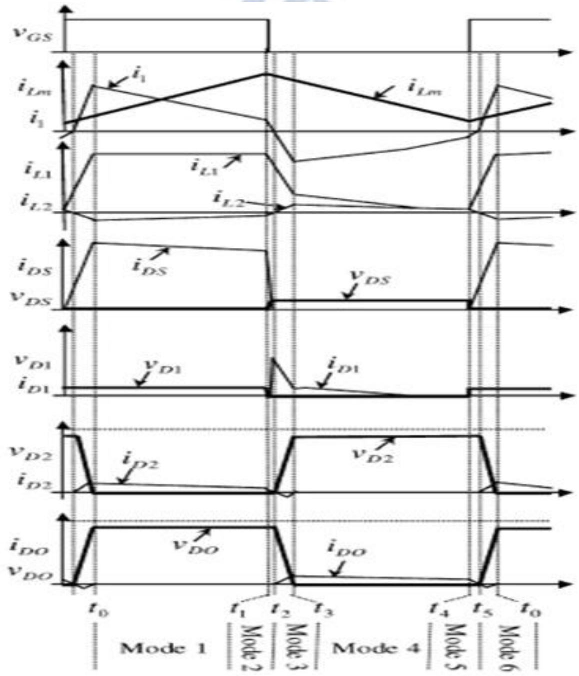

Fig 2 Characteristic waveforms.

3. SIMULATION RESULTS AND DISCUSSION

Simulink model-based Circuit diagram of PV with inverter in grid connected system is shown in Fig 3. Voltage across PV is shown in Fig 4 and its value is 48V. Switching pulse of inverter M2,M4 is shown in Fig 5 and its value is 1V. Voltage across RL load is shown in Fig 6 and its value is 140V. Voltage THDis shown in Fig 7 and its value is 7.43%. Current through RL load is shown in Fig 3.6 and its value is 12A. Current THD is shown in Fig 8 and its value is 8.42%. Real power is shown in Fig 9 and its value is 100W.Reactive power is shown in Fig 10 and its value is 750VAR.

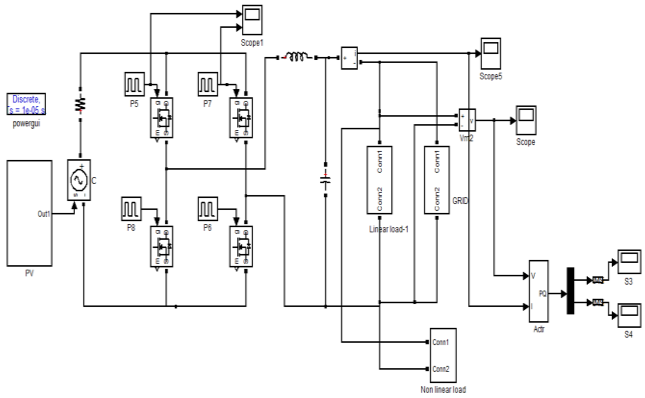

Fig 3 Circuit diagram of PV with inverter grid connected system

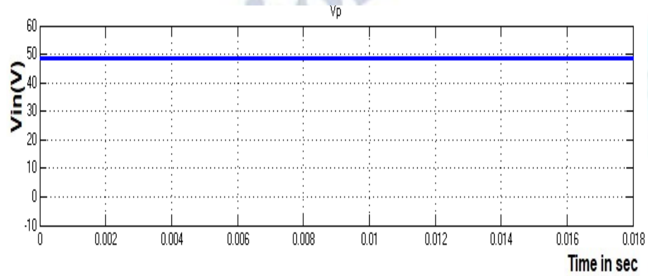

Fig 4 Voltage across PV

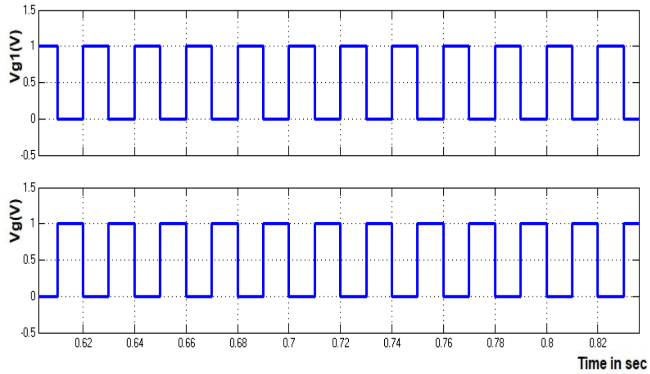

Fig 5 Switching pulse of inverter M2,M4

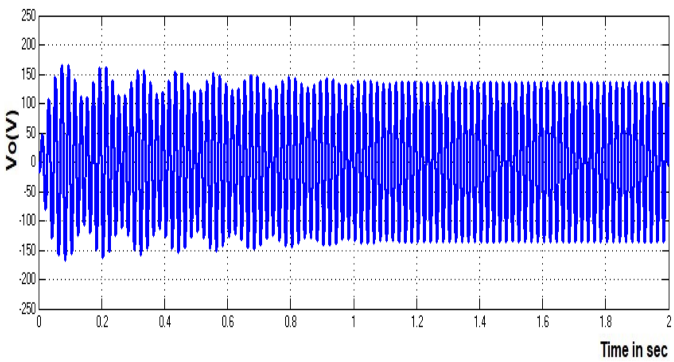

Fig 6 Voltage across RL load

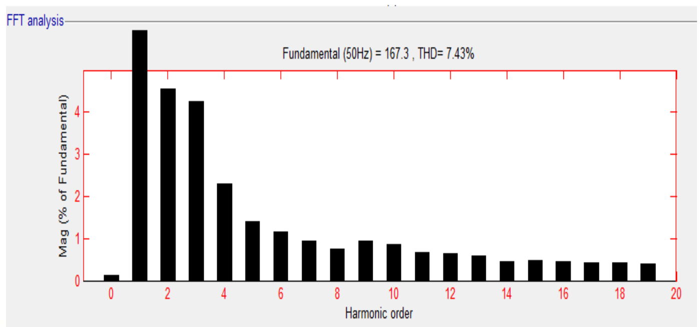

Fig 7 Voltage THD

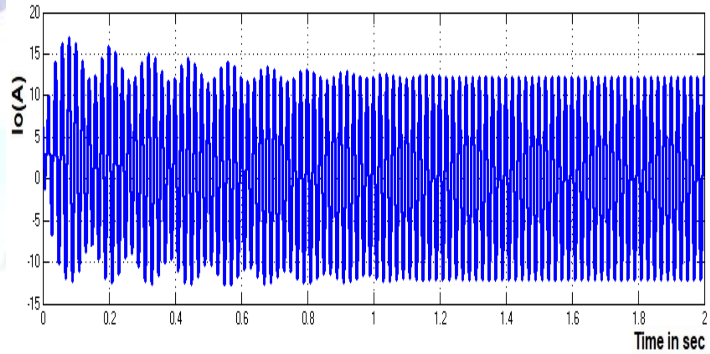

Fig 8 Current through RL load

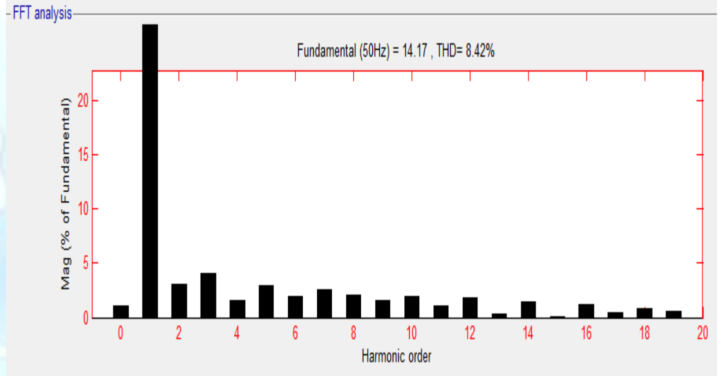

Fig 9 Current THD

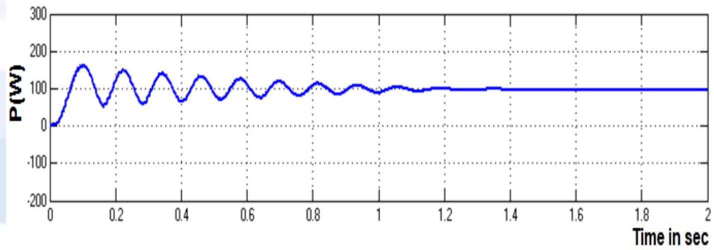

Fig 10 Real power

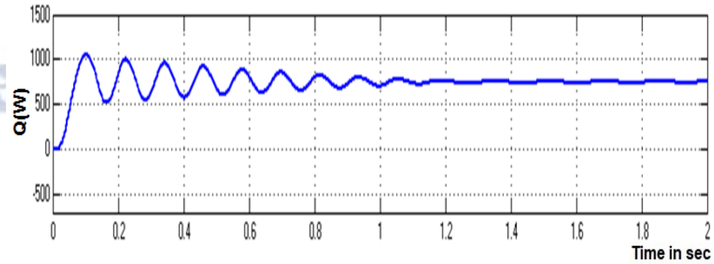

Fig 11 Reactive power

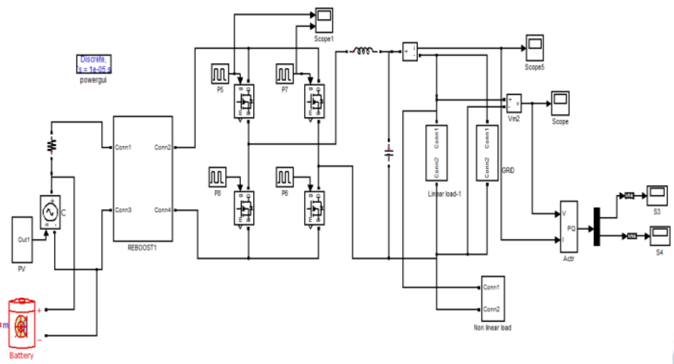

Fig 12 Circuit diagram of PV and Battery based Re boost converter with inverter grid connected system

Simulink model-based Circuit diagram of PV and battery based Re-Boost converter with inverter in grid connected system is shown in Fig 12 Voltage across PV is shown in Fig 13 and its value is 48V. Circuit diagram of Re boost converter is shown in Fig 14.Voltage across RL load is shown in Fig 15 and its value is 170V. Switching pulse of inverter M2, M4 is shown in Fig 15 and its value is 1V. Voltage across RL load is shown in Fig 16 and its value is 230V. Voltage THD is shown in Fig 17 and its value is 4.23%. Current through RL load is shown in Fig 18 and its value is 13A. Current THD is shown in Fig 19 and its value is 4.56%. Real power is shown in Fig 20 and its value is 175W. Reactive power is shown in Fig 21 and its value is 1300VAR.

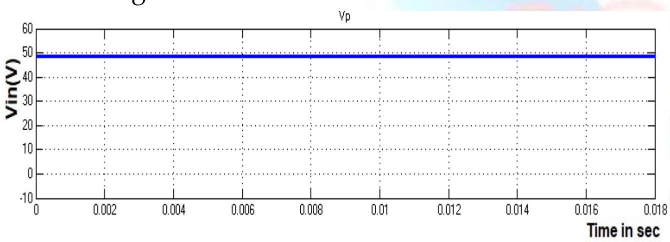

Fig 13 Voltage across PV

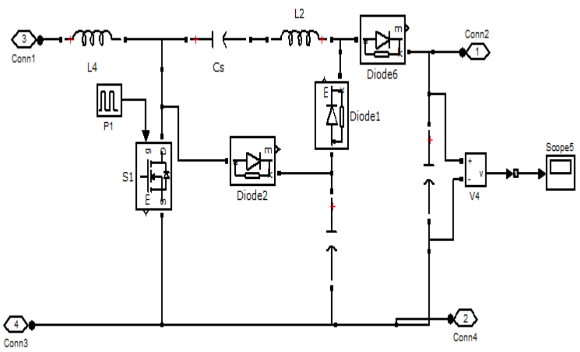

Fig 14 Circuit diagram of Re boost converter

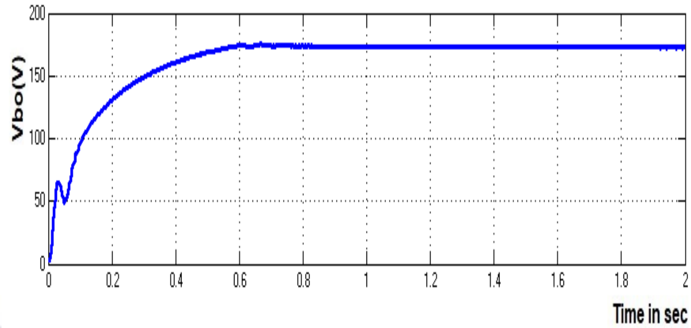

Fig 15 Voltage across Re boost converter

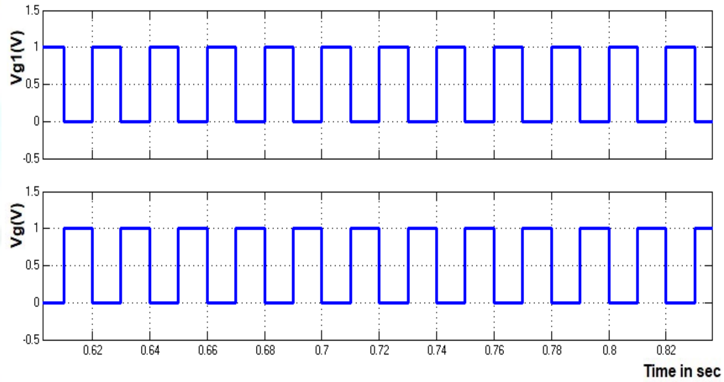

Fig 16 Switching pulse of inverter M2, M4

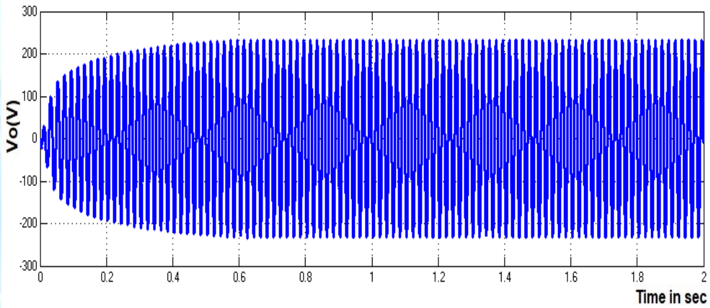

Fig 17 Voltage across RL load

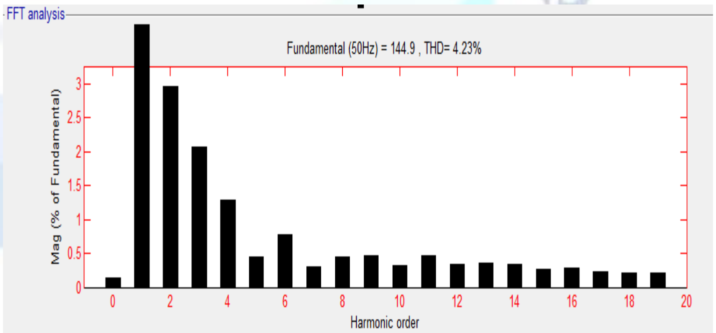

Fig 18 Voltage THD

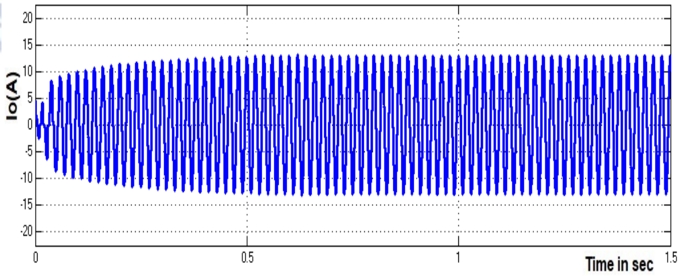

Fig 19 Current through RL load

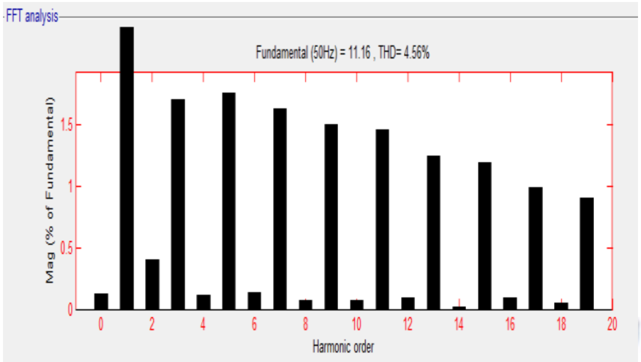

Fig 20 Current THD

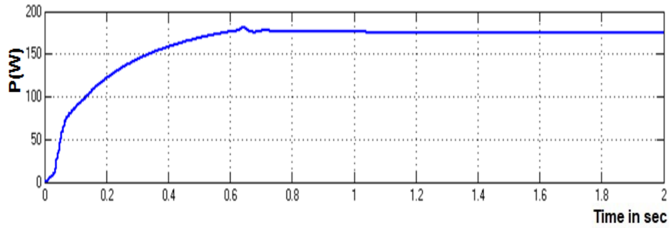

Fig 21 Real power

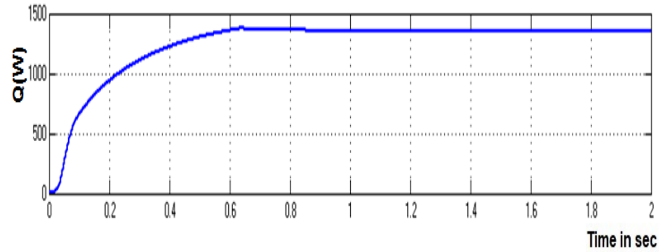

Fig 3.22 Reactive power

TABLE 1 COMPARISON OF OUTPUT VOLTAGE, OUTPUT POWER, OUTPUT VOLTAGE THD & OUTPUT CURRENT THD

PV & Battery based grid connected system	**Vin(V)**	**Vo(V)**	**P(W)**	**Q(VAR)**	**Voltage THD(%)**	**Current THD(%)**
PV with Inverter	48	140	100	750	7.43	8.42
PV & Battery based Re boost converter with Inverter	48	230	175	1300	4.23	4.56

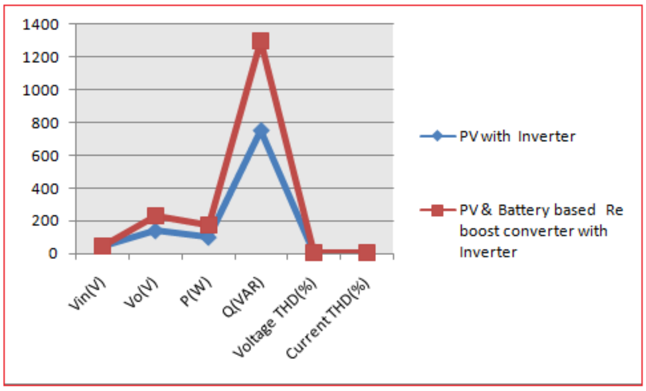

Fig 3.21 Bar Graph Comparison of output voltage, output power, output voltage THD & output current THD

Table 1 shows the Comparison of output voltage, output power, output voltage THD & output current THD for PV with Inverter and PV & Battery based Re boost converter with Inverter. The fig 21 shows the bar graph Comparison of output voltage, output power, output voltage THD & output current THD for PV with Inverter and PV & Battery based Re boost converter with Inverter. By using PV, wind and battery based Re boost converter with grid connected Inverter, Output voltage is increased from 140V to 230V;Real power is increased from 100W to 175W;Reactive power is increased from 750VAR to 1300VAR;Voltage THD is reduced from 7.43% to 4.23%;Current THD is reduced from 8.42% to 4.56%.

4. CONCLUSION

Existing PV with inverter in open loop grid connected system is simulated. Proposed PV, Wind and Battery based Re boost converter with inverter in open loop grid connected system is simulated. Above systems are compared. By using PV, wind and battery based Re boost converter with grid connected Inverter, Output voltage is increased from 140V to 230V; Real power is increased from 100W to 175W; Reactive power is increased from 750VAR to 1300VAR; Voltage THD is reduced from 7.43% to 4.23%; Current THD is reduced from 8.42% to 4.56%.

Conflict of interest statement

Authors declare that they do not have any conflict of interest.

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