Three Phase Utility Grid Controlling Using HCC Scheme

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Abstract - The full points of interest from hydrogen as a practical fuel can be accomplished exactly when it is delivered from environmentally friendly power sources. Wind and solar energy, as the most bountiful practical energy sources, have encountered the best improvement during several years. The basic goal of proposed research work to display and recreate a Photovoltaic wind half breed electric power framework related to the three phase electrical utility grid. The proposed PV Wind and fuel cell based REPS, considering all radiation, temperature, wind paces and variety of the heap interest during the day. A Matlab simulation has been completed to recreate all the boundaries of proposed REPS like inverter leg and current in each IGBT's for PV and WTG phase voltage. In this displaying and simulation work AC yield current of the inverter that infused to the heap/grid, load current, grid current, power yield from PV and WTG, power conveyed to or from grid lastly power factor of the inverter for PV, WTG and grid are outwardly examined on Matlab Scope dependent on simulation. In the proposed model a hysteresis current control and immediate p-q (real- nonexistent) power hypothesis has used. The exhibition of proposed model which actualized in the Matlab Simulink climate fills in as though ON-line has affirmed dependent on simulation and it is discovered proposed model has better authority over THD when contrasted with past work.

Keywords- Utility Grid, Fuel Cell, Hybrid Electric Power System, Hysteresis Current Control, Photovoltaic, Wind Energy.

I. INTRODUCTION

Limited scope blend of solar-wind-stockpiling has been discovered compelling in some autonomous power supply frameworks at distant territories. In the first place, a few plans have utilized a power converter interface in the battery association with control the charge-release cycle of the battery. In any case, a battery can be straightforwardly associated with the DC transport and be constrained by restricted variety of DC transport voltage. The power converters interfacing the wind and solar can infuse the power as a current source or voltage source. In addition, many consolidated energy power frameworks by utilizing different power electronic converters or control techniques have been advanced. Among them, reference presents a neural organization based control framework to facilitate between the segments of a PV-Wind crossover framework.

In contrast to batteries, fuel cells are gadgets that produce power as long as they are provided with a fuel. They depend on direct electrochemical change of a fuel and along these lines they are significantly more effective than inside ignition gadgets, arriving at operational efficiencies of 40%.

For little applications, under 100 kW, a proton trade layer (PEMFC) would be the most reasonable decision. The upsides of PEMFCs are: acceptable beginning stop capacities, activity in low temperature system and high power thickness. An ordinary fuel cell comprises of the electrolyte, in contact with permeable anodes, on the two sides. Low temperature fuel cells like PEM FCs require respectable electrocatalysts to accomplish down to earth response rates at the cathode and anode. To get usable voltages, the cells are consolidated in a stack, where they are electrically associated in an arrangement by a bipolar separator plate.

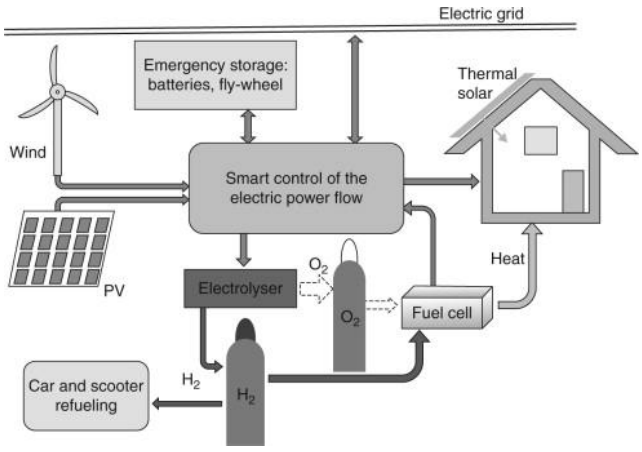

Figure 1.1 Renewable energy sources - fuel system.

Hydrogen based frameworks offer adaptability in estimating on account of seclusion of electrolyzers, fuel cells and capacity tanks and in this way can be changed in accordance with satisfy different requirements and requests. The intricacy of the hydrogen based framework, to guarantee a ceaseless inventory to satisfy the heap need, is extremely high; thusly the legitimate administration of energy and transitions between specific components is fundamental. The schematic of the sustainable power source – fuel cell framework (RES-FC) is appeared in Figure 1.1.

Operation of an electrolyzer and a fuel cell in combination with renewable energy source, especially wind and solar power, has several issues which need to be addressed.

II. UTILITY MICRO-GRIDS

A microgrid is a group of DGs and neighborhood stacks that can offer numerous preferences to the current power grid regarding power self-sufficiency and the capacity to join inexhaustible and non-environmentally friendly power sources. In the grid-associated activity, the DGs along with the utility grid supply power to the neighborhood loads. On the off chance that the power age is more prominent than the heap utilization, the overabundance can be either put away in the energy stockpiling unit or infused into the grid if there is a need. Then again, if the power age is more modest than the heap interest, more power can be imported from the grid. In the islanded activity, the DGs ought to have the option to give a steady voltage at the point of common coupling (PCC) and get the heaps naturally. What's more, the microgrid ought to be re-associated with the utility grid consistently when the grid is free.

Another promising capacity of microgrids is that each microgrid framework at the appropriation level can be filled in as a utility grid supporting auxiliary. With expanding entrance of the DG frameworks in to the electrical power appropriation organization, the DG frameworks could be outfitted with their own power converters with ability of providing receptive power or VAr utilizing power gadgets essentially for power transformation. This plan approach will assist utilities with lessening interest into voltage guideline gadgets in light of the fact that the use of static synchronous compensator (STATCOM) at the circulation voltage level isn't common because of the significant expense that the gear adds to the framework.

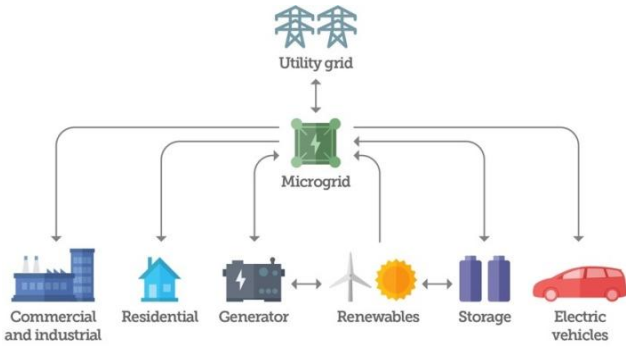

Figure 2.1 Microgrid system.

This new idea is getting increasingly appealing. Contrasted with a solitary DG unit, it offers numerous specialized points of interest as far as power quality and dependability. Contrasted with the entire power framework, it presents more control adaptabilities. Nonetheless, because of the broken idea of these DG units, the yield power isn't steady and may make negative impact the nature of power or harm the electric apparatuses. For the spread of sustainable power popular side, they should be introduced with offices which assimilate the vacillation. Likewise, because of the intricacy of a particularly little power framework including a few sorts of energy sources, energy stockpiling frameworks, and burdens, the planned control of these DGs to accomplish ideal power stream and keep up high power quality turns into a major test. From the viewpoint of the energy sources, the power converters ought to be controlled to catch the most extreme genuine power and infuse the abundance into the utility. Then again, from the utility/grid point of view, the power hardware interface ought to be additionally ready to give responsive power as per the necessity to improve power quality and upgrade grid security.

III. PROPOSED METHODOLOGY

In this work a simulink model dependent on hysteresis flow control stretegy has been executed for of photovoltaic, wind and fuel cell based mixture electric power framework 3 phase utility grid. Simulink model of propsoed framework has appeared in figure 3.1. This technique is considered as immediate control since the current is controlled in a deliriums circle. The hysteresis current control technique is basic, powerful, quick reacting, and simple to execute. An improved on square graph of Hysteresis-based current regulator has appeared in figure 3.2.

It likewise ensures a pinnacle current restricting ability. The strategy depends on the switch status, for example regardless of whether it is on or off when the current mistake contacts its low or high limit separately. To lessen the THD in the yield current, the hysteresis band must be diminished, however this would expand the exchanging misfortunes. Something else, a more extensive hysteresis band would expand the THD.

Hence, the hysteresis band is picked to bargain between the low THD and the low misfortunes. The straightforward hysteresis regulator has a variable exchanging recurrence and hence a moderately high THD. The recurrence band width in the current waveform relies upon the framework boundaries, the exchanging mode, the heap and the dc voltage. Further developed kinds of the regulator were created to restrict the transfer speed of the exchanging recurrence.

Simulink model of proposed control circuit has shown in figure 3.3 for three phase RES utility grid.

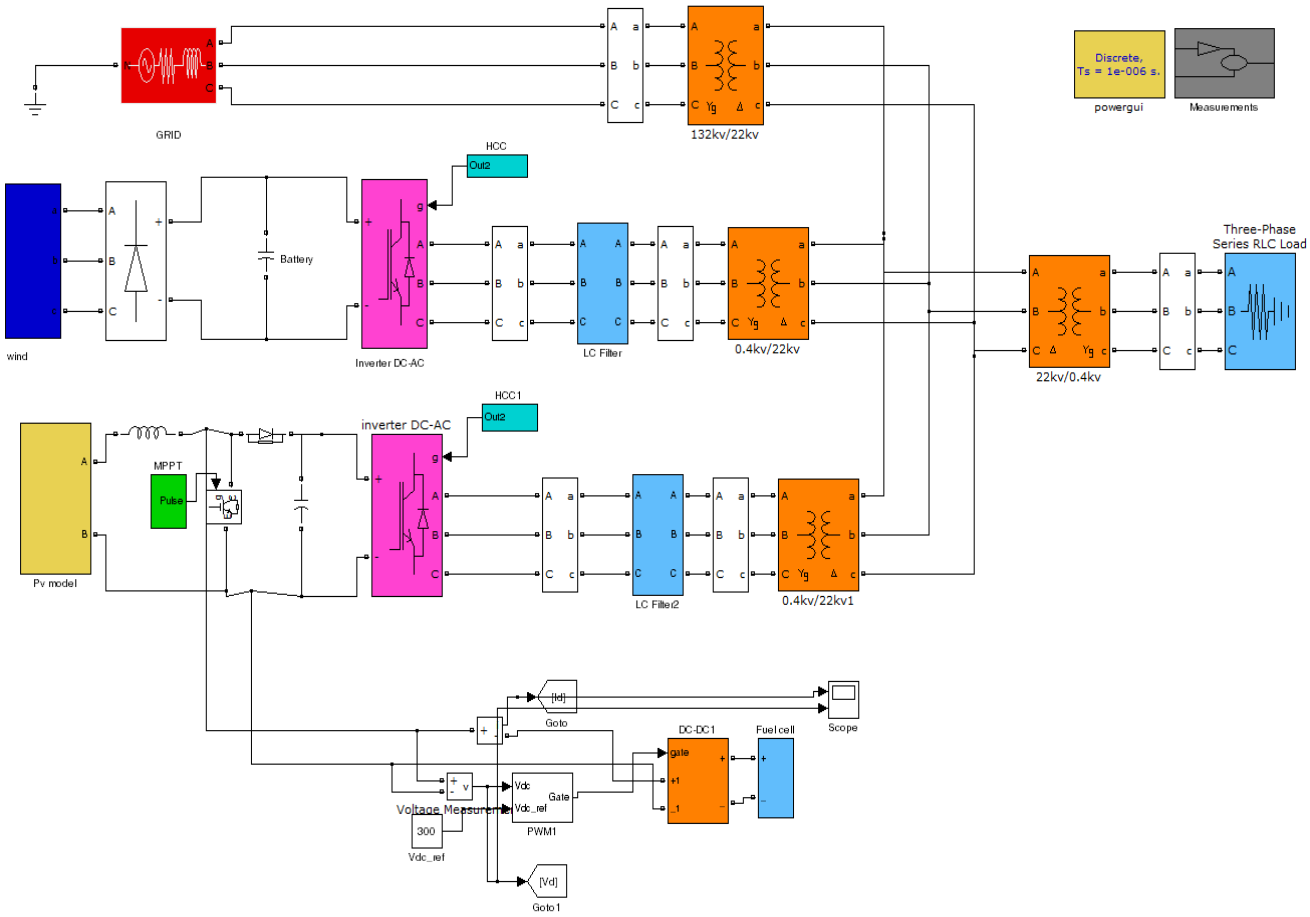

Figure 3.1 SIMULINK Model of Proposed System.

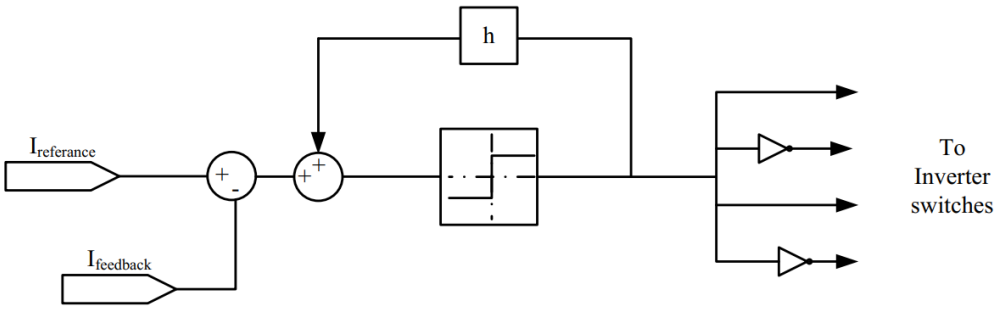

Figure 3.2 Hysteresis- based current controller.

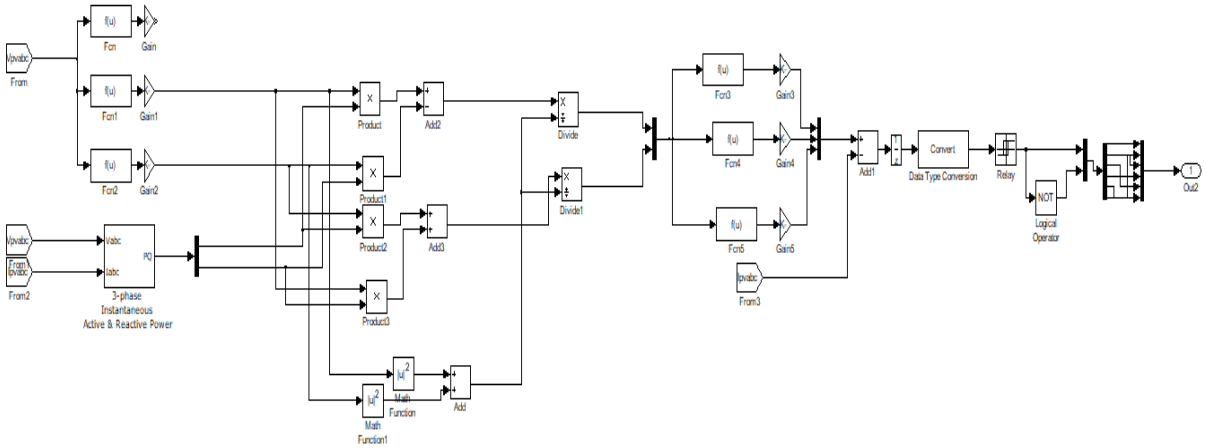

Figure 3.3 HCC Control Model of Proposed System.

IV. SIMULATION RESULTS

The verification of proposed model has done based on Simulation. Simulation of proposed model has completed in MATLAB Simulation environment. Various testing parameters waveform are visualized and analyzed on Matlab Scope. The fundamental objective of proposed work is to reduce distortion in current and voltage to achieve better power quality. As the market for small-scale renewable energy systems is rapidly increasing, the need for power electronic converters also increases. The inverter is necessary in the system to produce a sinusoidal wave to supply the ac load or connect to the grid.

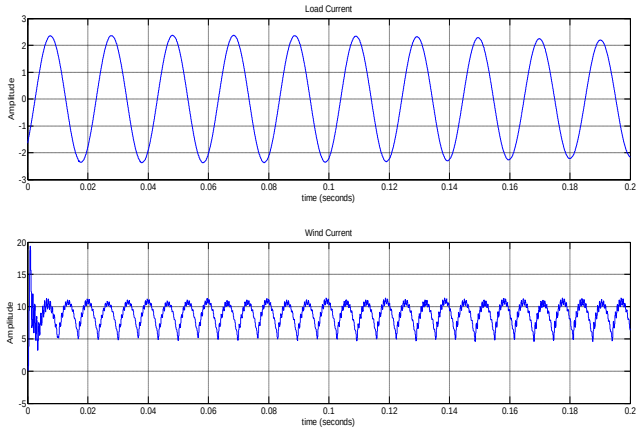

Figure: 4.1 Load Current and Wind Current

The proposed system in this study can be connected to the utility grid; therefore there are quality standards for such aspects as low THD, elimination of the dc component injected into the grid and active and reactive power control. Figure 4.1 shows the scope of load current and wind current waveform. In Fig 4.1 top waveform time vs amplitude and corresponding bottom waveform shows the wind current in terms of time vs amplitude.

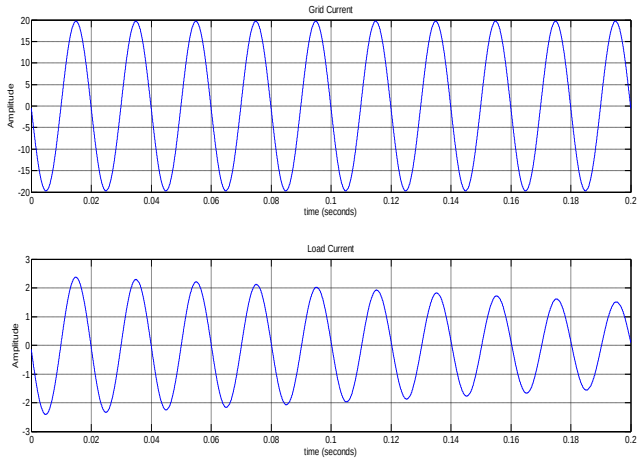

Figure: 4.2 Grid Current and Load Current Waveforms.

Figure: 4.2 shows MATLAB scope waveform of the grid current and load current of proposed model. The top one waveforms represents grid current and bottom corresponding bottom waveform represents load currentof the proposed model.

Fig. 4.3 shows the photo voltaic current waveform of proposed system. Fig shows the characteristics of PV current of proposed simulink model.

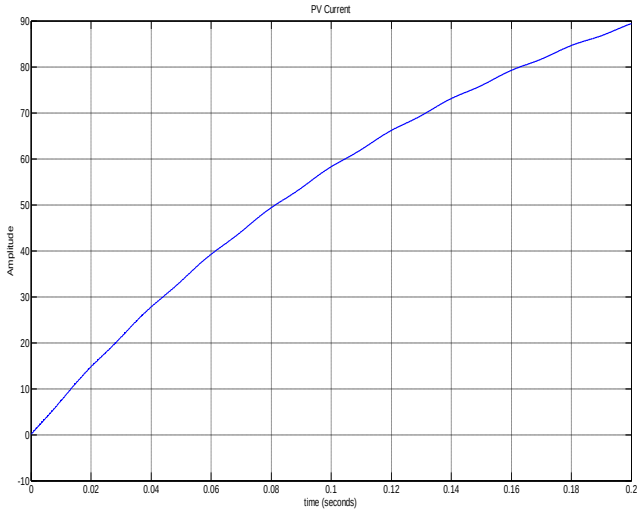

Figure: 4.3 PV Current

Fig. 4.4 shows the MATLAB Simulinkscope waveform of wind current and grid current on scope wind current and its corresponding grid current waveforms are plotted and examined.

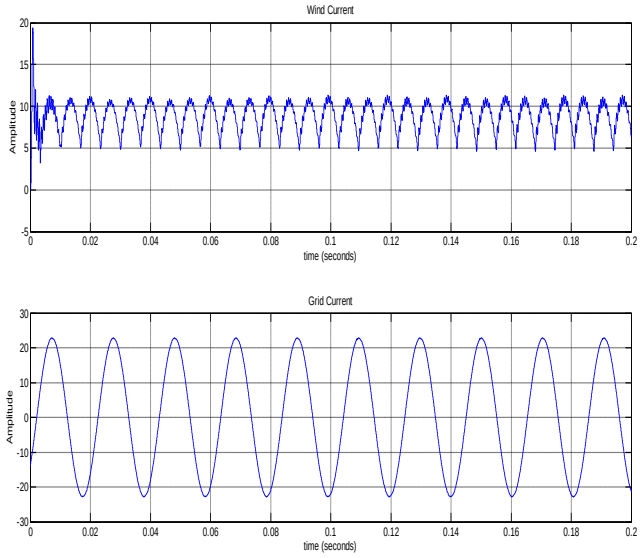

Figure: 4.4 Wind Current and Grid Current Waveforms

THD performance analysis of proposed work is shown in fig. 4.5 at fundamental frequency (50Hz)=9.066. The THD of proposed model has been recorded is about to 1.94% which was 30% is previous work.

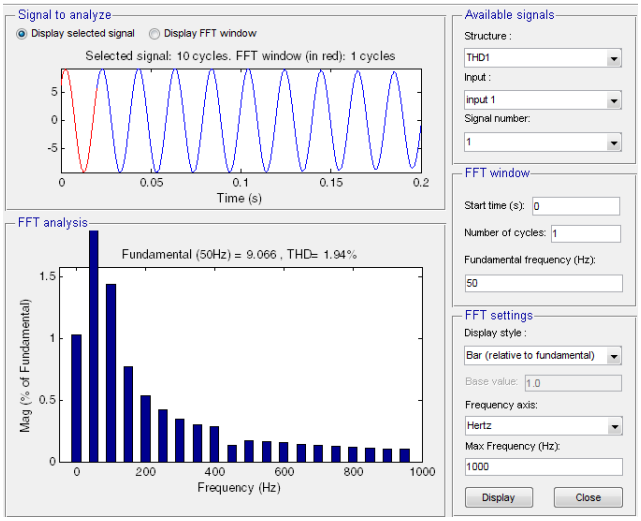

Figure: 4.5 THD reduced from 31.9 % to 1.94%.

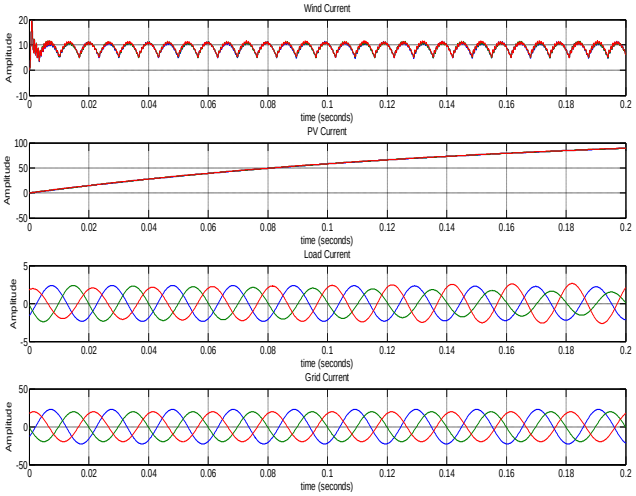

Figure: 4.6 Various Three Phase Waveforms of Proposed System.

Figure: 4.6 show various three phase waveforms of proposed system on MATLAB scope. The top most wave form is a wind current waveform top second corresponding to it is a PV current waveform below it load current waveform is plotted and at the bottom grid current waveform is plotted on Matlab scope. All the waveforms are carried out altogether to analyze the performance of proposed system on various aspects.

The comparative analysis between system without proposed model (Previous base work) and with proposed approach (Proposed model)utilizing current control technique based on Hysteresis investigation is appeared in table underneath table 4.1. Table 4.1 demonstrates the % of individual harmonics distortion w.r.t fundamental present in the system table demonstrates the Total Harmonic Distortion (THD) of the system using filter. As seen from the table Hysteresis Current Control of Photovoltaic, Wind & Fuel Cell Based Hybrid Electric Power System Interconnected with Three Phase Utility Grid having Hysteresis Current Control system strategy gives the better result as compare to the previous base work system.

Table: 4.1 THD Comparison

Previous Work Base Paper [1]	***Proposed Work***
31.9%	1.94%

V. CONCLUSION

This work presents implementation and simulation of MATLAB model of a hysteresis current control of photovoltaic, wind & fuel cell based hybrid electric power system interconnected with three phase utility grid. A photovoltaic, wind & fuel cell based hybrid electric power system can be connected to three phase utility grid, injecting power into the grid besides providing power to their local loads. It is therefore important to inject a low THD current from photovoltaic, wind & fuel cell based hybrid electric power system to grid at unity power factor. This can be achieved by using a hysteresis current control, which is simple, easy to design, and easy to implement. As a result, it will reduce the cost and size and increase the reliability of the generators. In this work THD reduced from 31.9 % to 1.94%.

In future there are following scope in proposed work

1. The implementation a microcontroller is also needed to the proposed PV wind & fuel cell based generator controller.

2. Experimental set-up is required for the verification of the proposed system with the power conditioning unit control.

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