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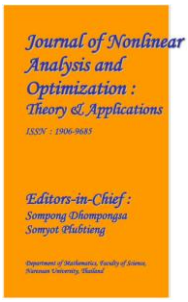

Unbiased Circular Leakage Centered Adaptive Filtering Control for Power Quality Improvement of Wind-Solar PV and Battery Energy Storage System

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ABSTRACT : **The Hybrid Renewable Energy Conversion Systems (HRECSs) and their increased penetration into the Utility Grid (UG) are increases the Power Quality (PQ) issues especially, in the form of increased Total Harmonic Distortion (THD) of voltages and currents at Point of Common Coupling (PCC). The objective of proposed grid tied Wind-Solar PV and Battery Energy Storage System (BESS) is to analyze PQ issues and to mitigate them by utilizing the Unbiased Circular Leakage Centered (UCLC) Adaptive Filtering control. An implementation of UCLC Adaptive control, improves the PQ indices and system performance by overcoming the intermittency issues associated with Solar and Wind energies. UCLC adaptive control effectively extracts the fundamental load current component and mitigates the grid current harmonics. BESS are commonly used for load leveling, peak saving, load shifting applications and etc. This BESS Block takes hourly Load Profile (kW) input from workspace and compute the Grid and Battery usage output to workspace.**

KEY WORDS : —UCLC Adaptive Control, Load Compensation, Wind Energy Generation, Solar PV Generation, Utility Grid, and Power Quality.

1. INTRODUCTION

The renewable resources such as, wind and solar are playing a major part in the global energy mix. They stand out to be inexhaustible, abundantly available, most promising resources for continually meeting the energy demand. The focus of the technocrats and the power providers, is to identify the period of highest load demand highest electricity price and highest generated power obtained by the renewables into the utility grid at that time. This acts as a source of additional revenue and can help in

recovering the additional capital used for the installation of the system.

THE glaring problem that the world, is facing today is the degradation of the environment due to escalating use of the fossil fuels and exploitation of the conventional natural resources, to meet the growing demand of energy. The awareness about environment and government initiatives, lead to the sense of conservation and rational utilization. The main aim at grass root level, is to challenge the structural designs and involved electro-mechanics in generation of power from the renewable resources.

2. CONCEPT OF POWER QUALITY

Power quality is the set of limits of electrical properties that allows electrical systems to function in their intended manner without significand loss of performance or life. The term is used to describe electric power that drives an electrical lood and the load's ability to function properly with that electric power. Without the proper power.

2.1 POWER QUALITY ISSUES

The PQ problems are categorized as follows

1. Transients
    (a) Impulsive
    (b) Oscillatory
2. Short-duration and Long-duration variations
    (a) Interruptions
    (b) Sag (dip)
    (c) Swell
3. Voltage unbalance
4. Waveform distortion
    (a) DC offset
    (b) Harmonics
    (c) Inter harmonics
    (d) Notching
    (e) Noise
5. Voltage Flicker
6. Power frequency variations.

1.TRANSIENT PROBLEMS:

Transients are very short duration (sub-cycle) events of varying amplitude. Often referred to as "surges", transients are probably most frequently visualized as the tens of thousands of volts from a lighting strike that destroys any electrical device in its path.

2. Short-duration and Long-duration variations

A. SAG:

The American "sag" and the British "dip" are both names for a decrease in voltage to between 10 and 90% of nominal voltage for one-half cycle to one mimite Sags account for the vast majority of power problems experienced by end users. They can be generated both internally and externally from an end users facility.

External causes of sags primarily come from the utility transmission and distribution network. Sags generated on the transmission or distribution system can travel hundreds of miles thereby affecting thousands of customers during a single event. Sometimes externally caused sags can be generated by other customers nearby

B. SWELL:

A swell is the opposite of sag an increase in voltage above 110% of nominal for one-half cycle to one minute. Although swells occur infrequently when compared to sags, they can cause equipment malfunction and premature wear. Swells can be caused by shutting off loads or switching capacitor banks on.

C. NOISE:

Noise is a high frequency distortion of the voltage waveform. Caused by disturbances on the utility system or by equipment such as welders, switchgear and transmitters, noise can frequently go unnoticed. Frequent or high levels of noise can cause equipment malfunction, overheating and premature wear.

D. NOTCHING:

Notching is a disturbance of opposite polarity to the normal voltage waveform (which is subtracted from the normal waveform) lasting for less than one-half cycle. Notching is frequently caused by malfunctioning electronic switches or power conditioners While it is generally not a major problem, notching can cause equipment, especially electronics, to operate improperly.

E. HARMONICS:

Harmonics are a recurring distortion of the waveform that can be caused by various devices including variable frequency drives, non-linear power supplies and electronic ballasts. Certain types of power conditioners like ferroresonant or constant voltage (CVT) transformers can add significant harmonic distortion to the waveform. Waveform distortion can also be an issue with uninterruptible power supplies (UPS) and other inverter-based power conditioners. The UPS does not actually add distortion, but because the UPS digitally synthesizes a waveform, that waveform may be square or jagged rather than a smooth sine wave.

3. SOLAR PHOTOVOLTAIC ENERGY CONVERSION SYSTEM

A sunlight based cell is fundamentally a p-n intersection which is produced using two unique layers of silicon doped with a little amount of contamination particles: on account of the n-layer, iotas with one more valence electron, called contributors, and on account of the p-layer, with one less valence electron,

known as acceptors. At the point when the two layers are combined, close to the interface the free electrons of the n-layer are diffused in the p-side, abandoning a territory decidedly charged by the givers. Additionally, the free openings in the p-layer are diffused in the n-side, abandoning a locale contrarily charged by the acceptors.

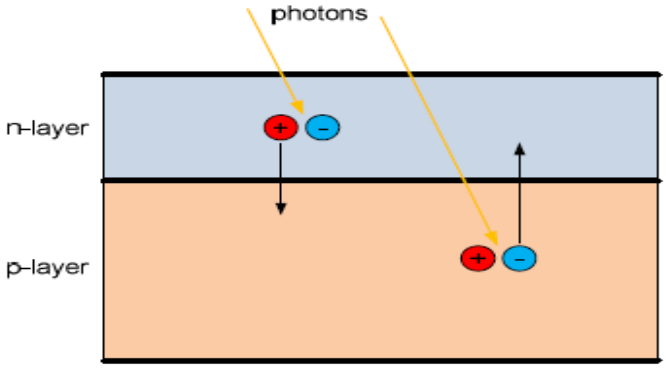


Fig.1 Solar cell.

This makes an electrical field between the opposite sides that is a potential boundary to additionally stream. The harmony is come to in the intersection when the electrons and gaps can't outperform that potential obstruction and thus they can't move. This electric field pulls the electrons and openings in inverse ways so the current can stream in one way no one but: electrons can move from the p-side to the n-side and the gaps the other way. A graph of the p-n intersection demonstrating the impact of the specified electric field is outlined. Metallic contacts are added at the two sides to gather the electrons and gaps so the current can stream.

4. WIND - ENERGY CONVERSION SYSTEM

Another innovative vitality arrangement given by wind vitality framework is encountering a high development rate as of late. Wind vitality frameworks are inescapable, openly accessible and condition cordial. The joined breeze diesel task is being prominent everywhere throughout the world since the accessibility of wind is flighty and relies upon geological and meteorological conditions. Half and half activity expands the unwavering quality of remain solitary framework, diminishes the creation cost and guarantees the accessibility of intensity.

This sort of framework is regularly utilized as a potential wellspring of electric power supply for off-lattice networks and offices. This part shows the basics of wind vitality change framework (WECS), numerical displaying of wind control extraction, electrical generator and power electronic converter interface. A most extreme power point following technique is connected to improve the task of wind turbine and the machine side converter controller enables access to control the speed. The displaying of diesel generator and control framework for diesel vitality transformation framework (DECS) is clarified in this part.

5. Battery Energy Storage System

The battery energy storage system (BESS) is an advanced technological solution that allows energy storage in multiple ways for later use. Given the possibility that an energy supply can experience fluctuations due to weather, blackouts, or for geopolitical reasons, battery systems are vital for utilities, businesses and homes to achieve a continual power flow. A battery energy storage system is no longer an afterthought or an add-on, but rather an important pillar of any energy strategy, especially any energy strategy that makes use of renewable solar power. The sun is a wonderful energy engine, but it has one, significant limit: no sunshine, no power production. By combining battery energy storage with PV solutions, the batteries can mitigate the intermittent nature of renewable power by storing solar power produced during the day for nighttime use, thus guaranteeing a steady supply of power at all times.

6. Hybrid Operation

A Hybrid Solar-Wind and battery energy storage System Optimization Sizing (HSWOS) show was produced to improve the limit sizes of various parts of sunlight based breeze crossover vitality framework. It utilizes a battery bank to store the power produced. Numerical displaying of a sun oriented photovoltaic module, wind turbine and capacity bank was talked about to mimic the conduct of the sunlight based breeze half and half vitality framework. The financial model in view of the Levelized Cost of Energy (LCE) show has been proposed to comprehend the cost viability of the framework. An ideal blend of a crossover sun based breeze vitality framework must fulfill both the solid and practical necessities. In mixture activity of sun oriented breeze framework, wind vitality is regularly given need since the accessibility of wind is more prominent. An essential power administration is proposed where wind is given need over sun powered PV. Sun powered PV framework can be worked in the daytime when it is conceivable to work the breeze turbines both amid day and evening time.

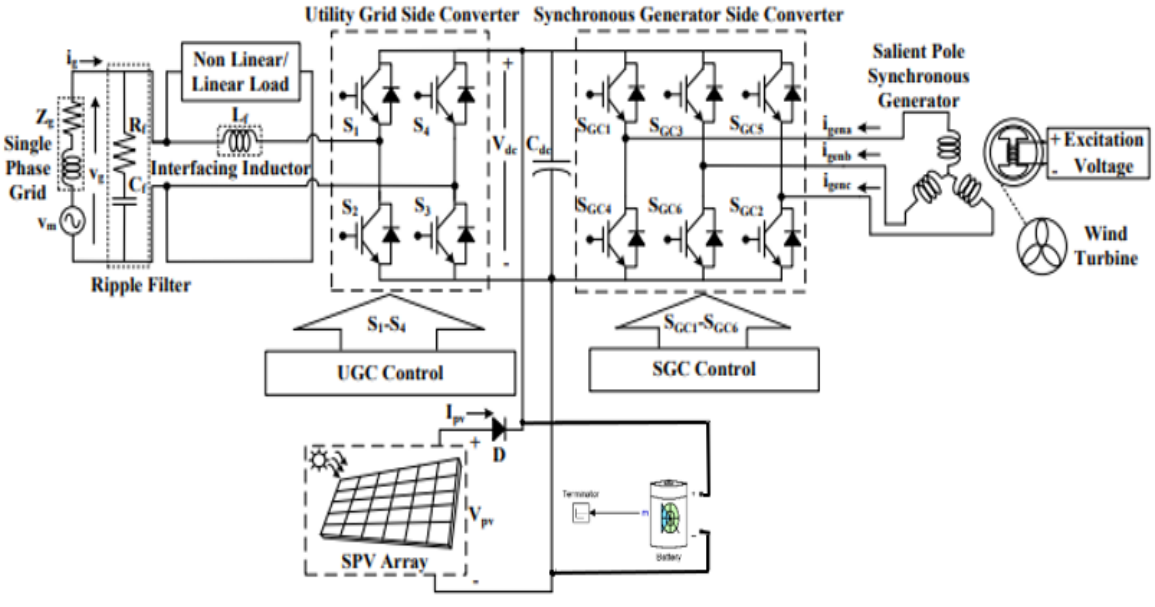


Fig . 2 Hybrid Operation

7. Block Diagram

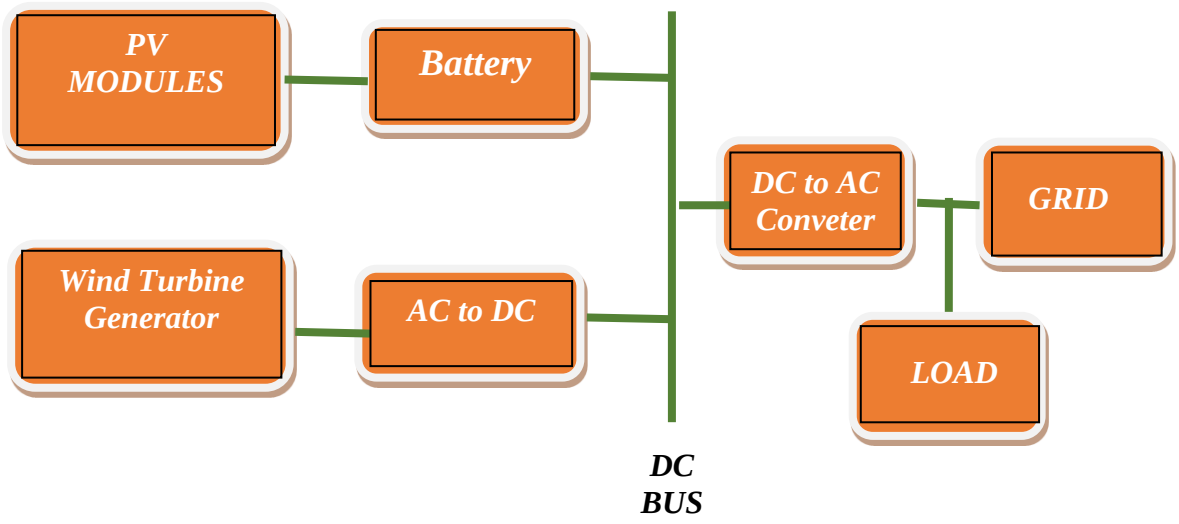


Fig. 3 Block Daigram

RESULTS

SIMULATION CIRCUIT :

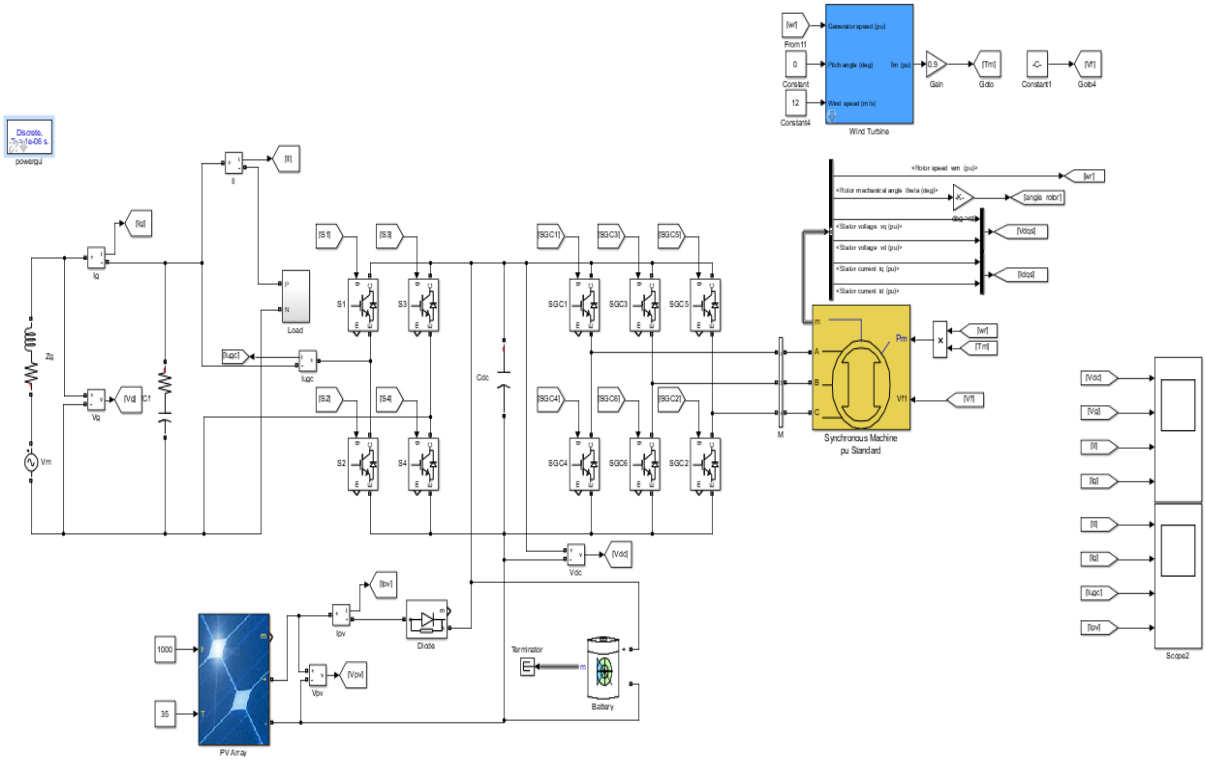


Fig. 4 SIMULATION CIRCUIT

- The above Fig represents Model of Simulink for Wind-Solar PV and Battery Energy Storage System in a Simulink model
- Here Battery Energy Storage System acts as both the power providing and power receiving source

without any disturbances of intermediate power fluctuations.

- So , including with UCLC which is used to improve the power quality and to reduce the harmonics in voltage and current the system , by using the Battery Energy Storage System as an intermediate and additional power source we can increase the overall efficiency of the system .
- And we can also ensure that proper uninterrupted and continuous power supply to the grid to meet the grid demands whenever it needed high amount of power supply whenever the production is less in any one of the power plant.

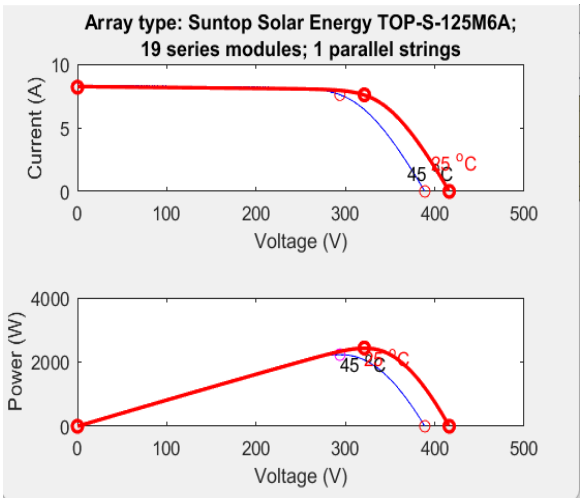


Fig.5 Parameters of PV Array

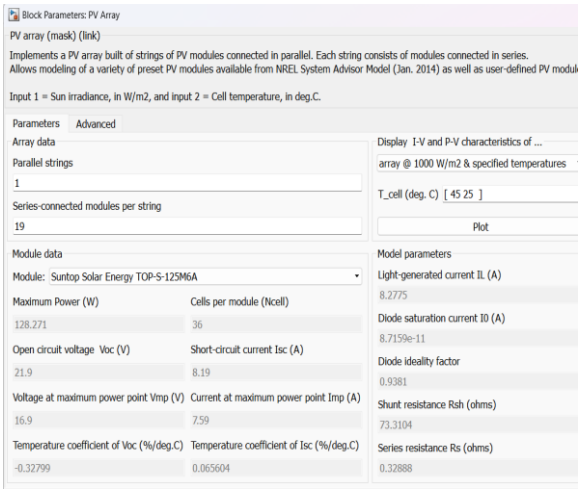


Fig.6 I-V and P-V Characteristics of PVArray

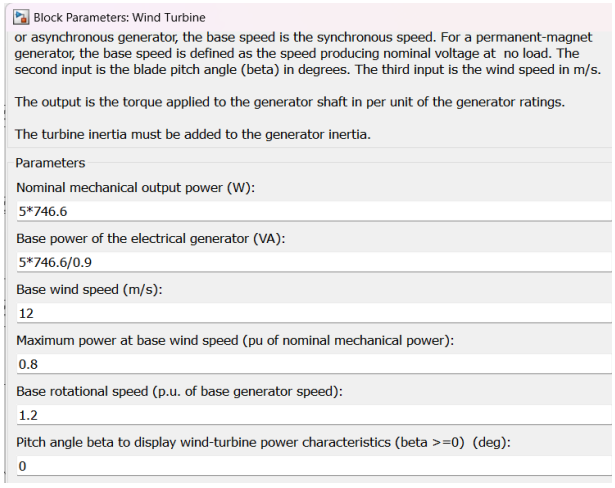


Fig.7 Parameters of Wind Turbine

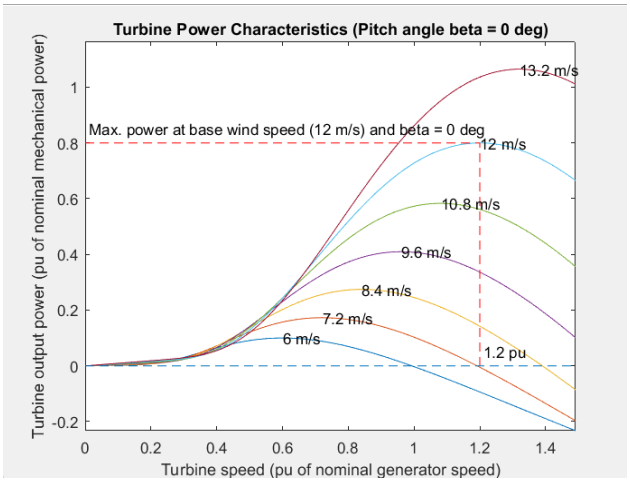
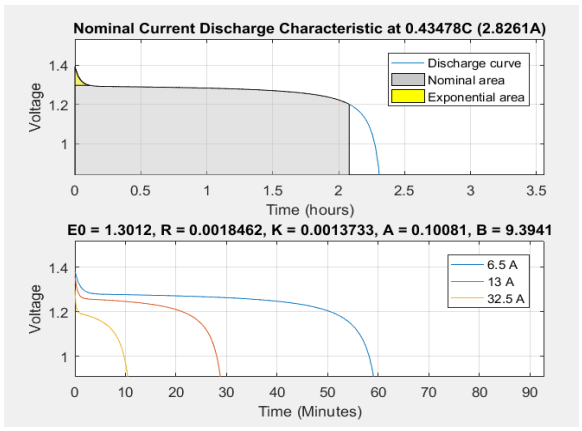


Fig.8 Wind Turbine Power Characterist



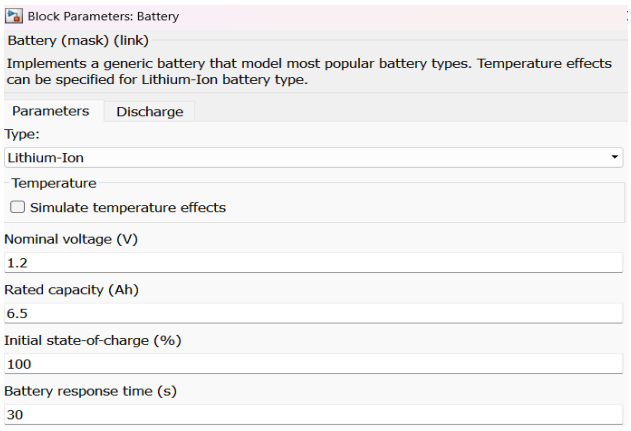


Fig. 9 Parameters of Battery

Fig. 10 Discharge Characteristics of Battery

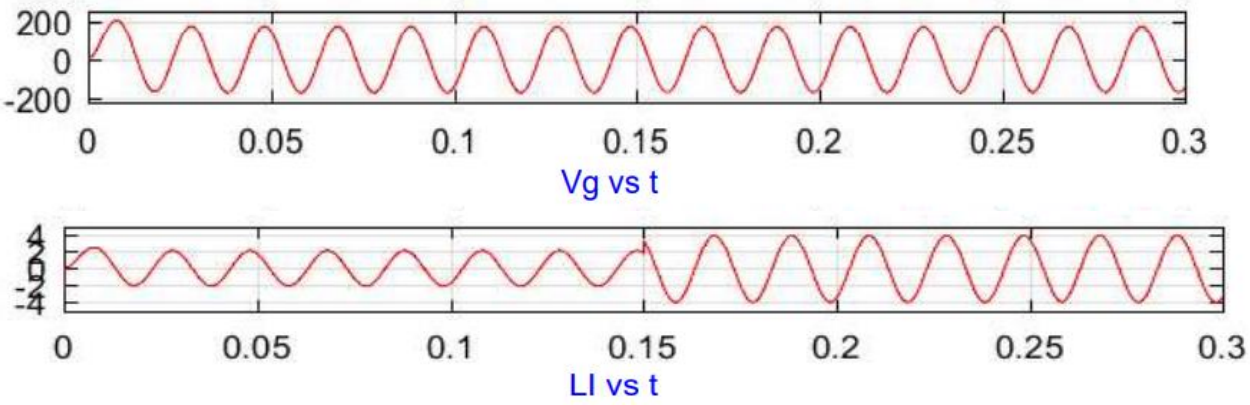


Fig. 11 Grid Voltage and Load Current with sag and swell PQ Issues

- The above shown fig 6.8 Grid Voltage and Load Current with sag and swell PQ Issues when ever coupling of wind and solar and battery management system the sag and sell one of the power quality issues occur in the load current.
- The below shown Fig 6.9 is Grid Voltage and Load Current after Eliminating the PQ Issues with by using UCLC Adaptive Filtering and Battery energy storage system to improved power quality Utility Grid

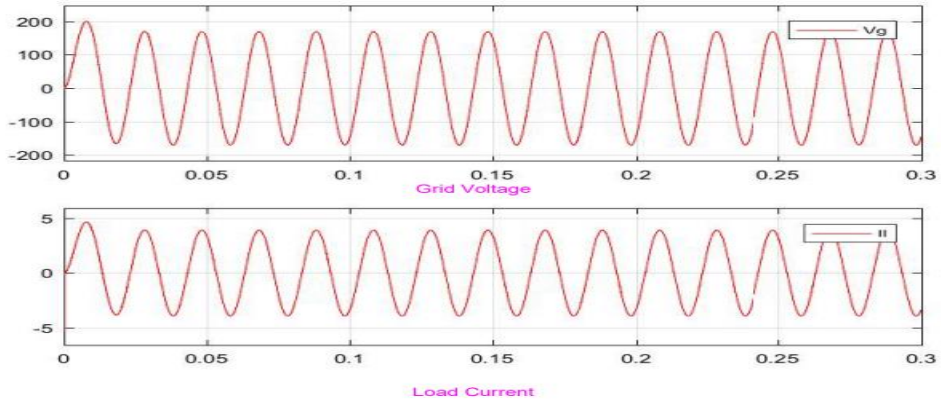


Fig.12 Grid Voltage and Load Current After Eliminating PQ Issues

CONCLUSION AND FUTURE SCOPE

The UCLC adaptive filtering control for wind-solar PV and Battery energy storage system has been implemented successfully on a MATLAB its performance in accordance to the dynamic wind speed conditions, varying solar insolation level and altering load demand. The concluding remarks are summarized as follows.

- UCLC adaptive filtering scheme has successfully mitigated the grid current harmonics and enhanced power quality is attained at the input AC mains.

- UCLC has effectively estimated the sinusoidal fundamental active load current component by filtering the disturbances and harmonics component.

- It has provided improved filtering response in both steady state and dynamic conditions.

- An improved proficiency of the control technique has been observed by successful extraction of fundamental load active component.

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