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Energy Management of AC Grid by the Solar PV System Using Landsman Converter

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Abstract:
The proposed system illustrates the reduction in power quality problems faced in the power system and the power electronic devices that causes current harmonics, unbalanced loading and voltage unbalance due to increase in reactive power. To solve these problems, grid current should be maintained, harmonics should be reduced, energy systems should be maintained, reactive power compensation should be maintained and the power demand should be satisfied. This system focus onthe design of the solar PV with Landsman converter (DC – DC) attached to the AC grid. Along with solar PV, a Battery Energy Storage System (BESS) is present to balance the power run in the proposed model. A globalised MPPT is achieved through the Fuzzy Logic Controller to abstract the maximum power from the solar PV system irrespective of change in the input obtained. Power flow Management System is attained by the Bidirectional converter with BESS. The dc voltage from the Landsman converter will be fed to the Voltage Source Inverter (VSI) and the output AC voltage isassociated with the three phase AC grid. Grid synchronisation will be achieved by the Hysteresis Controller using d-q theory with Park and its inverse and then Clarkes and its inverse Transformations is also used. Fast Fourier Transform (FFT) is used to derive the THD values and the system efficiency values are measured. This proposed model will be simulated using MATLAB and its efficient performance can be identified.

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I. INTRODUCTION

Globally, there are many remote areas where they are lacking in the electricity. To overcome the shortage of electricity, many solutions are required for the free flow of power in economical way. One of the main solution is the introduction of the grid to the system. When grid is connected to the system, the electricity issues will be solved to a maximum limit. Even though, the grid could clear the problem, the remote spots lack from power loss for about 9 to 11 hours. But a permanent solution to the electricity problem is given by Renewable Energy Sources (RES) like solar PV, wind energy system, biomass etc. are available in a wide range. RESdelivers the sufficient power to compensate the power transmission for remote areas. The specialty of RES is the replacement of the grid power by means of the environment friendly power. The habit of Renewable Energy Sources ie, solar, wind etc. will provide a pollution free environment rather than the biomass power. So the usage of the wind and the solar power will be encouraged globally. Though, both these power are advantageous in numerous ways, there are many drawbacks like higher liability

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to vary, less capacity usage and uncertain in nature. Due to the negative feedbacks of RES, assurance of firm power is very low. To succeed this negativity, a Battery Energy Storage (BES) can be introduced. The major role of BES is the reduction in power fluctuations, increasing power forecasting and higher utilization factor that rises by functioning the Renewable Energy Sources in MPPT and obtain an efficient output. Maximum Power Point Tracking (MPPT) is the appropriate tracking method of maximum power which regulates a set point for the wind energy cohort and solar PV system in idioms of speed and voltage to obtain the extreme power output. Power Electronics based Fuzzy Logic Controller (FLC)obtains the extreme power from the Renewable Energy Source (RES). Energy Management for BES can also be maintained by the power electronics control. Mostly due to the advantageous nature, the Standalone Renewable Energy system is preferred because of its operating conditions in rural areas where the transmission and distribution of power are difficult to develop [1]. The autonomous system satisfy the needs of electricity in remote areas and the operating cost of the system will be reduced. Certain standalone applications use a Varying Phase Angle Control method (VPAC) is applied for managing the energydriftamid the solar PV battery and the DC link by means of Isolated Bidirectional DC Converter (IBDC) [2]. In this model, the Bidirectional DC Converter is put inamong the DC link and hybrid renewable energy sources. Using adaptable controllers, a continuous supply is maintained at critical loads even when the grid is unavailable [3]. An island detection scheme is used in the case of non-detection zone to achieve maximum accuracy. In certain standalone microgrid purposes, extraordinary performance is obtained from the wind turbine without sensing the speediness of the rotor or the wind by power ratio variable step–based P&O method and PV system with reduced oscillations and tracking the maximum power under steady state conditions [4]. Certain RES with solar PV and diesel generator, the losses due to harmonic mitigations are reduced by using a cost effective LCL filter. By using mitigation techniques in solar PV system, mismatched errors like partial shading, temperature variations can be sorted out [5]. Certain studies about RES deals with the dynamic droop scheme in PV systems for acapable load distribution with other RES, in absence of Energy Storage Systems (ESS). Unit Vector Template (UVT) is used for bidirectional power flow among the system plus the grid without speed sensors and position sensors are used. The cost of the system will be reduced due to the absence of sensors and the stability of the system issustained irrespective of the change in input [6]. Variouscategories of converters like Boost converter, Buck converter, Buck – Boost converter, Non inverting Buck – Boost converter are used in Hybrid Energy Source (HES) comprising of solar PV and WECS that uses different optimization techniques to obtain Global Maximum Power Point Tracking (GMPPT) and the estimation of Total Harmonic Distortion (THD) is attained for diverse operating situations. The design of solar PV and WECS are described and they are applied in the proposed model [7] – [11]. Many application oriented research papers uses SRG, PMSG based WECS in DC microgrid system. To fulfill the load required and to preserve the stability of system, multiple generators will be connected in parallel and the model predictive control algorithm is operated in the inverter side of the system to maintain a steady power movementamidst source and the grid [12] – [14]. New model battery functioned Electric Vehicle using Landsman converter is operated to develop the power factor also thereby reducing the current ripples and current harmonics to develop the power quality, robustness of the system [15]. Bridgeless Landsman PFC Converter is used on BLDC motor for low power appliances and sensors are used for computing the control of DC bus [16]. The Hybrid Energy System with Landsman converter is used in the projected system to maintain the stability of the system by reducing the current harmonics and by maintaining a good power features of the model. The HES with solar PV, WECS, Diesel generator, and Battery storage unit controls the voltage and frequency by Back Propagation Feed Forward Control in VSC that reduce the harmonics occurring in the system. The quality of the power and voltage is developed by Model Predictive Control Strategy and droop control method is used for smooth AC voltage output and to satisfy the power required. Thus the overall system performance is enhanced [17] – [19]. In the case of islanded or non-islanded AC microgrid, a fundamental based fault current limiter is used to suppress the fault current [20]. Before AC grid usage, the architectural design, protection, grounding of the DC microgrid and its advantages like reliability, efficiency and control has been discussed [21]. An AC or DC microgrid with Hybrid Energy System (HES) consisting of solar PV, DFIG or any other generator for WECS, diesel generator, hydro, battery etc. used for voltage regulation and frequency regulation, power management, levelling and control by FLC. Global MPPT procedures are applied to achievesupreme power. The grid can be interfaced by multiple distributed generators through power inverters and the control schemes are smeared for maintaining the stable operation of voltage and frequency in the approach. The HES have tomaintain parallel synchronization to balance the voltage output from the different input sources [22] – [27].

II. PROPOSED SYSTEM

The proposed method describes about the smooth power movement of the solar PV source toward the AC grid by means of Landsman converter. RES like solar PV model acts as source of the proposed method. The fluctuating output DC voltage obtained from the solar PV source is nurtured to the Landsman converter (DC - DC converter). The PWM generator fed the PWM pulses to the transistor or IGBT switch present in the Landsman converter.The greater extent power is attained from the solar PV system through Fuzzy Logic Control MPPT algorithm where the voltage and the current from the solar PV system isserved as the input to the Fuzzy Logic Controller (FLC). The boosted voltage from the Landsman converter is fed to the Voltage Source Inverter (VSI) and later the power is fed to the AC grid. L and C filters are existing in between the VSI and AC grid to prevent the harmonics from the output voltage of the VSI.To balance the energy course in the intended model which is achieved by the BESSattached to the DC link by Bidirectional DC converter. The system acts as an Energy Management System by means of the Battery storage present in the system

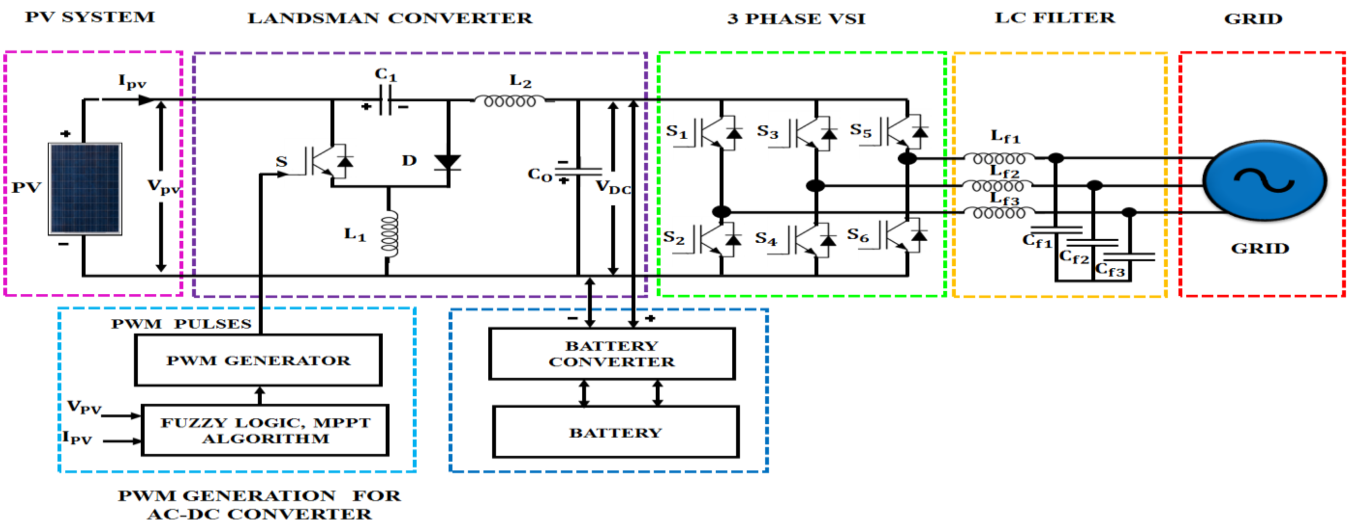

Figure 1: The Proposed Model

A. Solar PV system:

The solar PV system is made up of solar photovoltaic that absorbs and converts the solar power that produces electricity from the sunlight. The solar panels should be fixed on a strong and stable construction such that they can bear wind, rain, hail and corrosion. The solar PV array must be set at a fixed angle where the angle depends on the positioning of the structure, local altitude and the electrical load necessities. The solar modules in the northern hemisphere must be pointyin the path of south because the southern hemisphere is oriented at a directionequivalent to the local latitude. The ground mounted solar panels opt to move the panel towards the sun across a single axis or double axis to track the highest power from the sun. This is one of the effective method but maintenance cost is more.The ensemble solar panels together identified as arrays where the solar panels are attached in parallel or series and it is represented as Np or Ns.Based on the characteristics of solar cell, the open circuit voltage, Voc and the short circuit current, Isc can be found. The yielded voltage and current from the solar PV can be considered as Vpv and Ipv. MPPT helps to abstract the highest power, Pmpp from the solar PV system and the peak voltage and peak current is given by Vmpp and Impp respectively. The solar panels produce solar power from the sunlight based on the variable input solar intensity and temperature. This power generated is fed to the FLC based MPPT system in order to extract the peak power from the system ie, highest voltage and highest current. FLC is a type of logic controller that contains a assured set of rules that are framed for the system on our choice to get the controlled output. Then the fuzzy logic output is fed to PWM generator which fed the gate pulse to the switch present in the DC – DC converter based on the delay angle output. Then the output from the Landsman converter is fed to the Voltage Source Inverter (VSI) where the DC output will be transformed to the AC output by means of VSI and then the output AC voltage is fed to the AC grid. The LC filters are applied to eradicate the harmonics existing in the AC signal. The output AC voltage is found from the output DC voltage by means of the formula given as Vdc = Vac / √2.

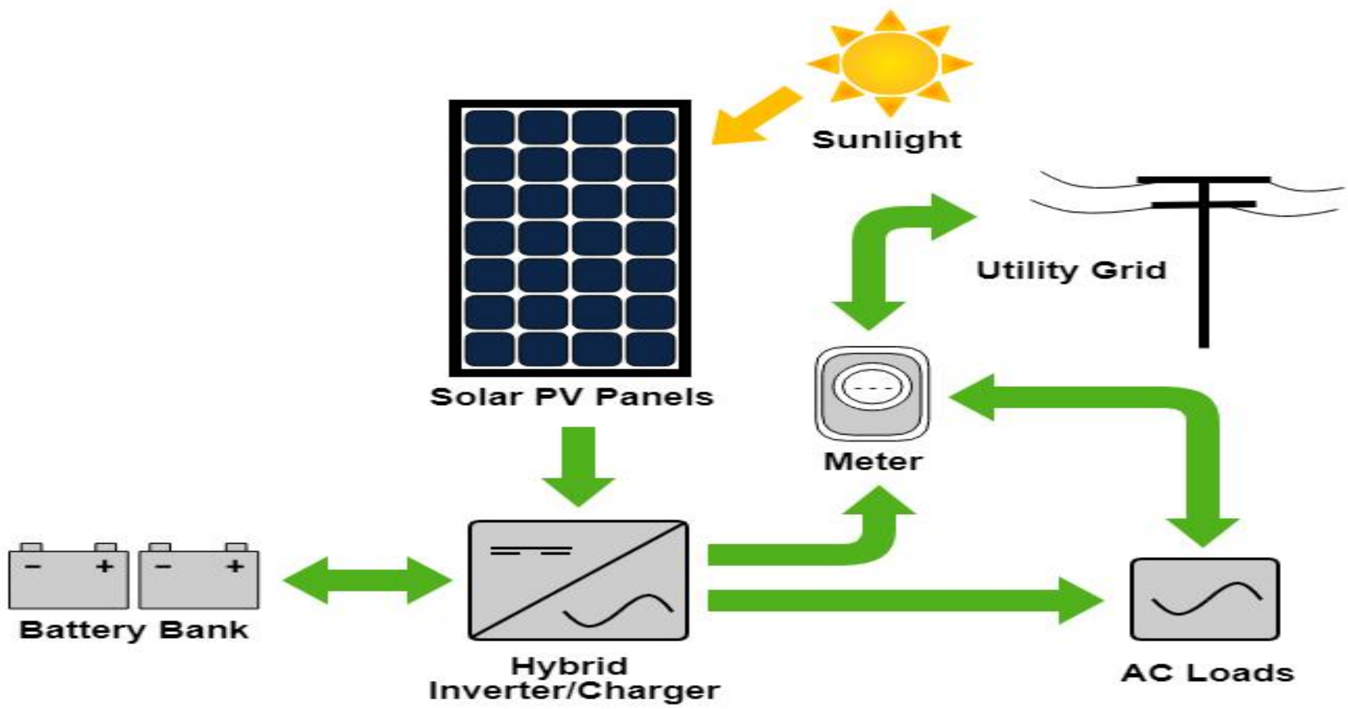

Figure 2: Solar PV System connected to the grid

B. Design of Landsman Converter:

Landsman converter is the DC – DC converter that steps high the voltage received from the solar PV system. This converter functions at higher efficiency and provides a noiseless operation. This electric power converter fed the step up DC voltage to the three phase Voltage Source Inverter (VSI). The transistor or IGBT switch is fed by the PWM pulses generated by PWM generator. The maximum power (Pmpp) input is fed to the PWM generator by the MPPT algorithm organized by FLC. The input Vpv and Ipv for the FLC is fed from the solar panel. The components present in the Landsman converter can be derived from the following set of equations. The duty Cycle D is derived by the equation (1) given below,

$$D = Vdc / (Vdc + Vmpp) \quad (1)$$

Where Vdc is the output DC voltage from Landsman converter and Vmpp is the maximum power point voltage value obtained from the FLC based MPPT algorithm. The capacitance value, C1 present in the Landsman converter is given by the equation (2) given below,

$$C1 = (D \times Idc) / (fsw \times \Delta Vc1) \quad (2)$$

Where the output dc current from the Landsman converter is given by Idc, fsw represents the switching frequency of value 10KHz and ΔVc1 is 20% of voltage across C1, Vc1.The Idc value is given by Vmpp + Vdc. The inductance, L1 value is given by eqn (3),

$$L1 = (D \times Idc) /(8 \times fsw^2 \times C1 \times \Delta I_{L1}) \quad (3)$$

Where the value of the variation of current across inductance, $_{L1}$ is given by 3% of I_{L1}. The current across inductance, I_{L1} value is equal to the maximum peak power point current value, Impp. The value of the inductance, L is given by the following equation (4),

$$L = (D \times Vmpp) / (fsw \times \Delta I_L) \quad (4)$$

Where the value of ΔI_L is 3% of current across inductance L,I_L. I_L is the summation of Impp and Idc. The value of Idc = Pmpp / Vdc. The high level frequency capacitance, Ch and the low level frequency capacitance. Cl is given by the eqn (5) and eqn (6),

$$Ch = Idc / (6 \times \omega h \times \Delta Vdc) \quad (5)$$
$$Cl = Idc / (6 \times \omega l \times \Delta Vdc) \quad (6)$$

The value of ωh and ωl is given by (2π x Nrated x P) / 120 and (2π x N x P) / 120. The value of ΔVdc is given by 4% of output DC converter voltage, Vdc. The design of the Landsman converter specifications are mentioned

C. Fuzzy Logic Controller:

FLC is the controller excerpts the maximum peak power from the solar PV system irrespective of the variations in the input temperature or input solar irradiation or other environmental factors. Fuzzy Logic Controller frame the membership rules based on the conditions present in the solar panel. The resulted current and the voltage of the solar panel is fed to the FLC where the MPPT algorithm is applied to abstract the highest power from the solar panel. The below diagram explains about the FLC based MPPT algorithm.

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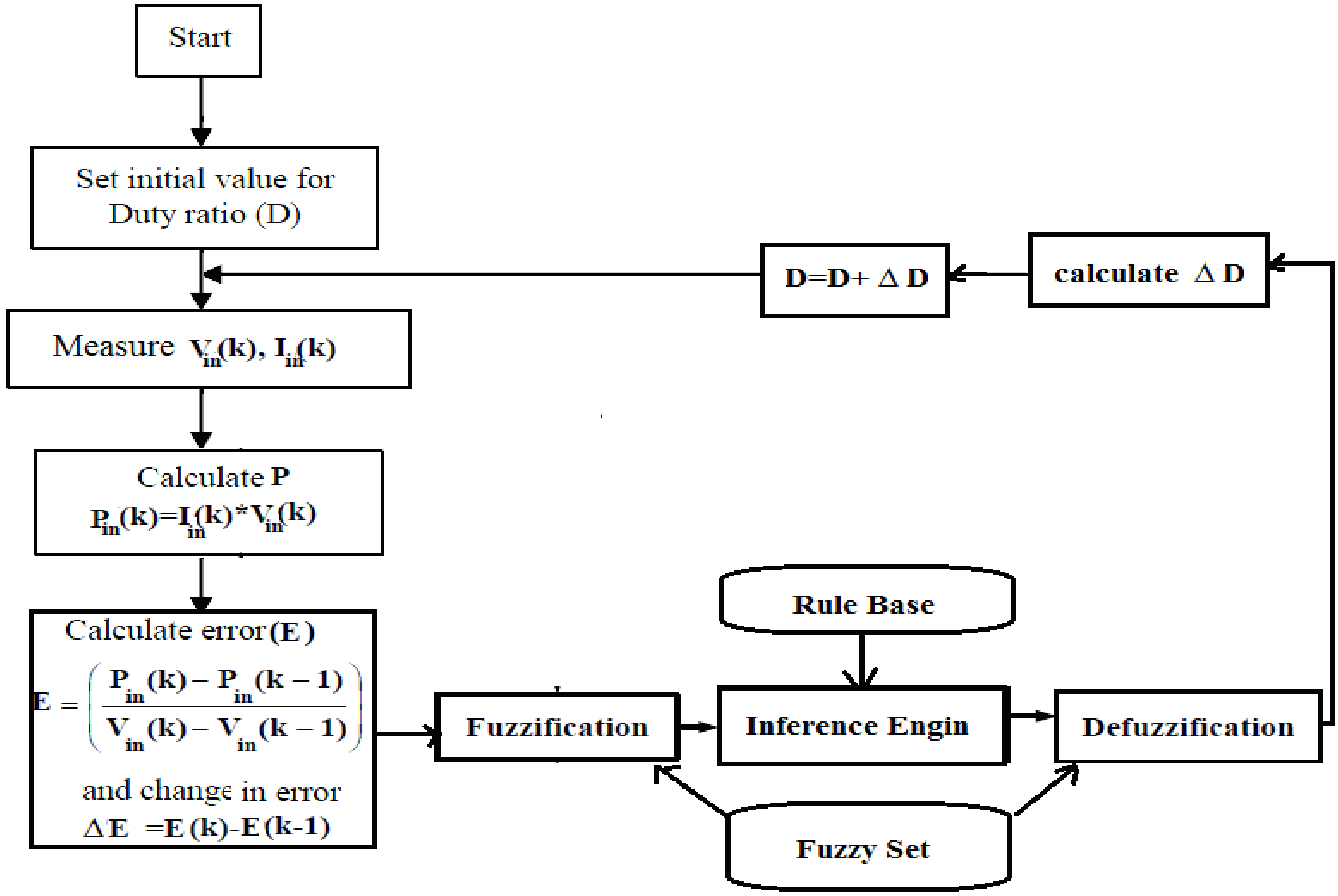

Figure 3: FLC based MPPT Algorithm

FLC is a man - made rules centered operation where voltage value will be considered to acquire the peak power. The duty ratio value will be calculated. Then the value of the voltage and current from the solar output is measured. The worth of the power from the voltage and current input can be calculated. The value of the voltage as error and change in error will be designed using FLC. Fuzzy Logic Controller has three process. They are Fuzzification, Inference Engine and Defuzzification.Fuzzy set of rules framed will identify the category of output obtained from the system. The duty cycle is calculated and then the output maximum power and voltage value also calculated and fed to the PWM generator.

D. PWM Generator:

The pulse width modulated signal is generated by PWM generator and applied to the switch present in the Landsman converter. PWM generator actually chops the reduction of the average power into discrete parts. The voltage and current average values supplied to the load side by keeping the switch ON for a longer time than OFF time. Due to this longer ON time, the power delivered will be more. The PWM generator is fed by the FLC based MPPT controller to obtain the high peak power values. The main function of the PWM generator is to produce pulse width modulated gate pulse signal and fed to the switch present in the Landsman converter.

E. Battery Energy Storage System:

It balances the power movement in the system in the situation of the nonexistence of the power generated from the source. It generates a smooth power stream from the source to the grid even in the lack of the source power. It can act as a source to the entire system and also can act as a storage unit. BESS is joined to the DC link by means of the Bidirectional DC converter which is a two way process converter.

The Bidirectional converter supplies and absorbs the power.

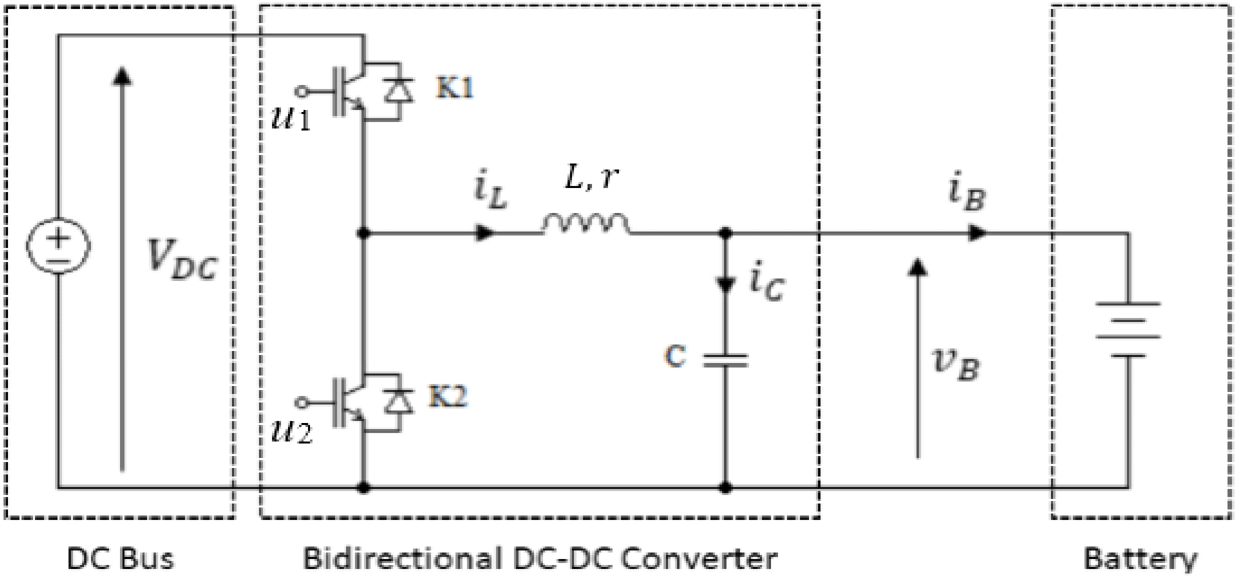

Figure 4: Battery Energy Storage System

F. Voltage Source Inverter:

Ittransforms the DC output voltage fed by the Landsman Converter to an AC output voltage that is fed to the AC grid. The AC voltage converted will contain harmonics.

G. L and C Filters:

The harmonics generated from the three phase voltage source inverter will be reduced by means of the L and C filters present before the AC grid. So the voltage generated will be free from harmonics before feeding the AC grid.

H. AC grid:

The load side of the system acts as the grid. The AC grid is otherwise known as the power grid and it meets the load demand by means of using RES like solar PV system, wind energy system etc. AC grid is used to transmit the electric power to the distribution side of the customers.

III. Results And Discussions

The procedure of the proposed work has been verified through MATLAB/ SIMULINK software platform.Table1 and 2 represents the parameter specifications /ratings of the solar system and Landsman Converter

Table 1. Specifications for the Solar panel

Components	Ratings/ Specifications
No of panels	30
No of cells in series	36
Cell	125mm×31.25mm
OC voltage	21.4V
Optimum operating voltage	16.8V
SC current	1.21A
Optimum operating current	1.19A
Operating temperature	-40 to +85^{0}C
Maximum system voltage	1000V DC

Table 2. Specifications of Landsman converter

Components	Symbol	Rating
Source Voltage	Vin	0 to 300 V DC.
Source Current	Iin	75 A (Max)
Capacitors	C1,C2	20uF
Inductor	L1,L2	7mH
Output load current	IL	60 Amps
Switching frequency	Fsw	10 KHZ
Output Power	Po	15kW

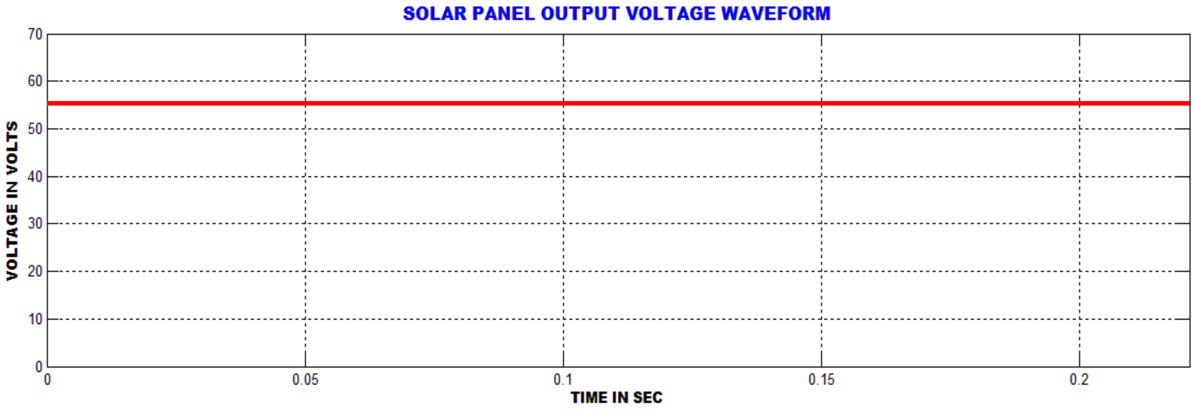

Figure 5: Solar panel output voltage waveform

The figure 5 describes the PV panel output voltage waveform, 36 cells are either attached in series and parallel to create the solar Panel. 1000 W/m2 irradiation and 25 degree temperature are maintained to take the waveforms. This voltage is given to the Landsman converter for step up the output voltage.

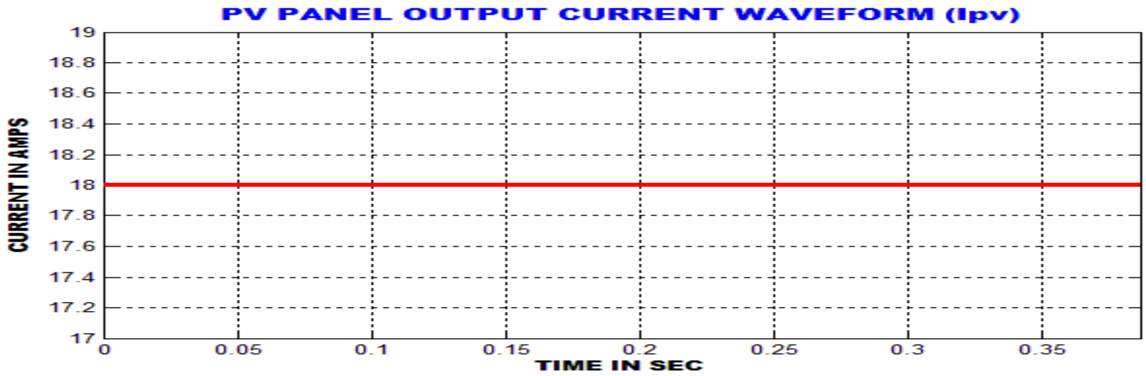

Figure 6: Solar panel output current waveform

The figure 6 describes about the solar output current waveform, the current, Ipv and solar voltage, Vpv are taken as a reference for fuzzy logic MPPT algorithm.

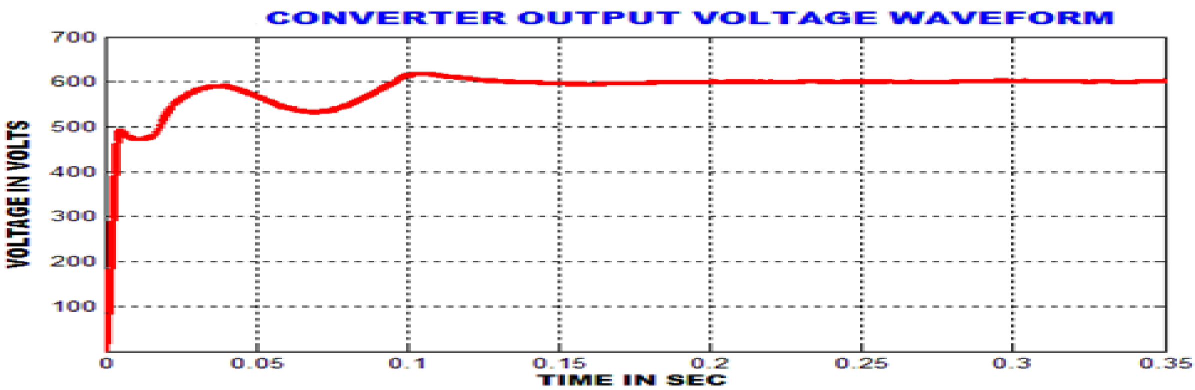

Figure 7: Landsman Converter output voltage waveform

The fuzzy logic algorithm conservespersistent output voltage, i.e its tracks extreme power from the PV system. Landsman converter reduces ripples in the output voltage waveform, this constant DC voltage is specified to the three phase inverter for AC load applications. Meanwhile, this voltage is provided to the battery converter for battery storage.

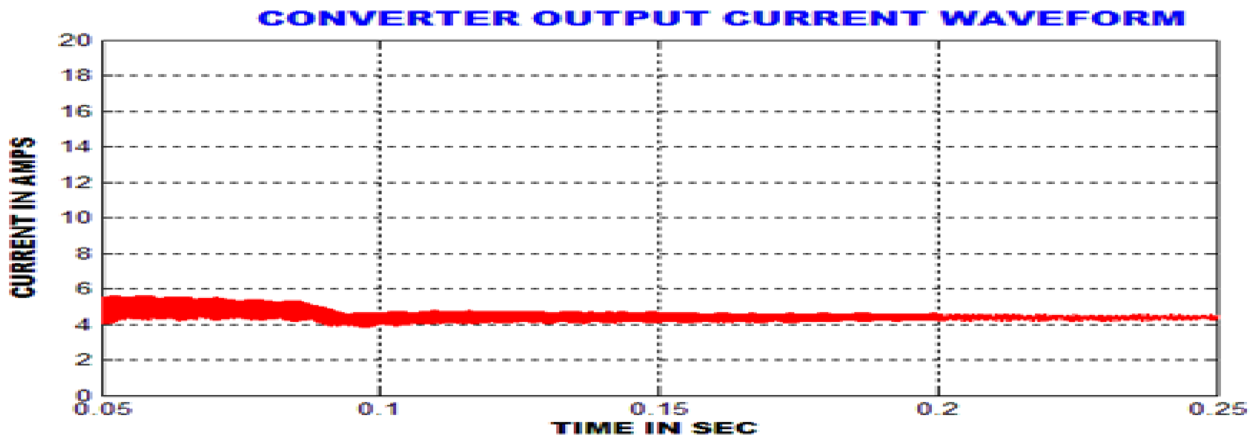

Figure 8: Landsman Converter output current waveform

The figure 8 shows Landsman converter output current waveform, Landsman converter maintains continuous current operation, due to continuous current operation efficiency of the PV system gets increase.

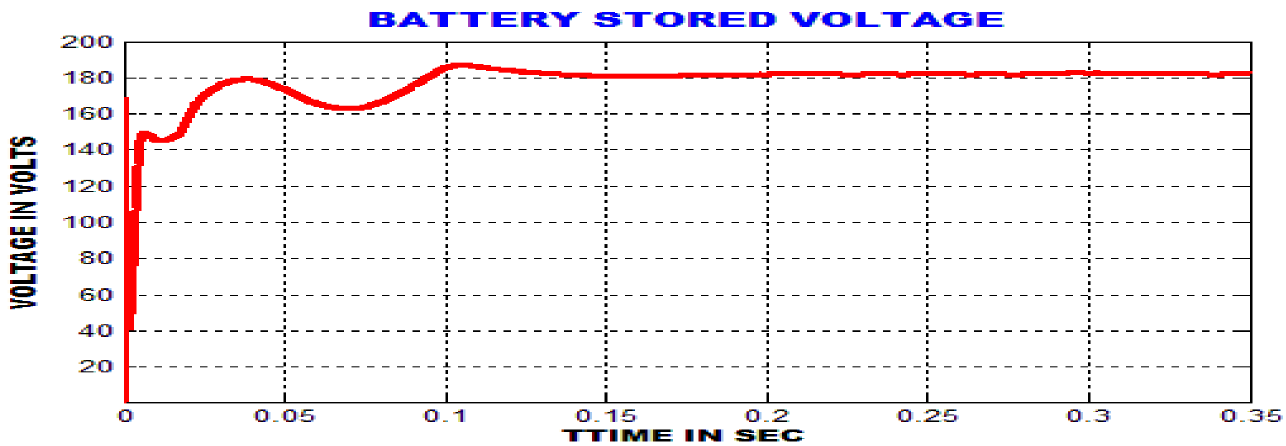

Figure 9: Battery voltage waveform

The figure 9displaysthe battery voltage waveform and the bidirectional battery converter is applied for charging anddischarging operation. While charging, the converter works in buck mode and during discharging, the converter functions in boost mode.

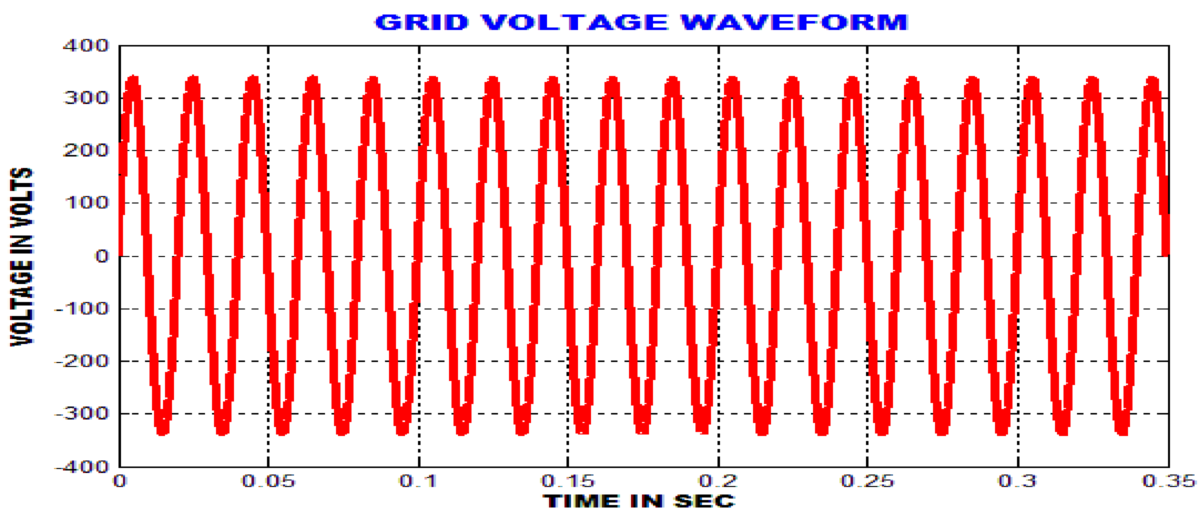

Figure 10: Grid voltage waveform

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The figure 10 presents grid voltage waveform. Hysteresis current controller achieves grid synchronization. PI controller based grid synchronization decrease the harmonics in the output voltage and the grid current waveform. Here both the grid voltage and current waveform are sinusoidal in nature due to the grid synchronization technique.

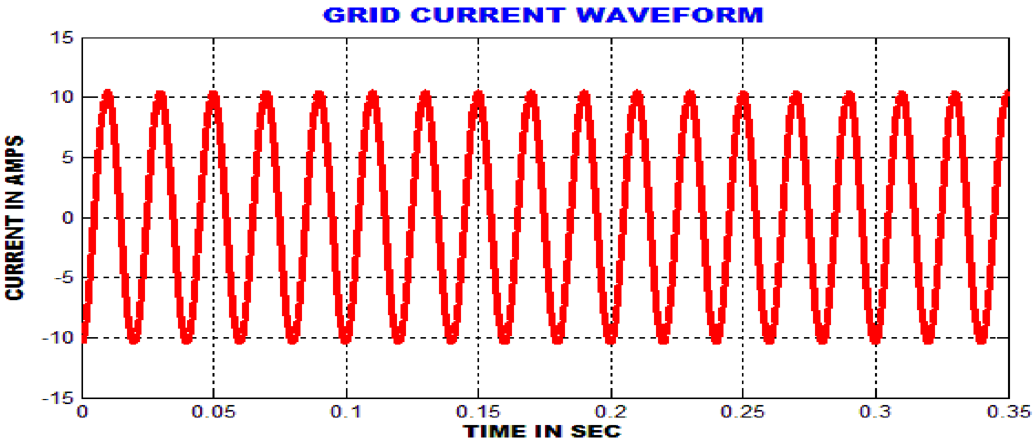

Figure 11: Grid current waveform

The figure 11 describes about the grid current waveform obtained.

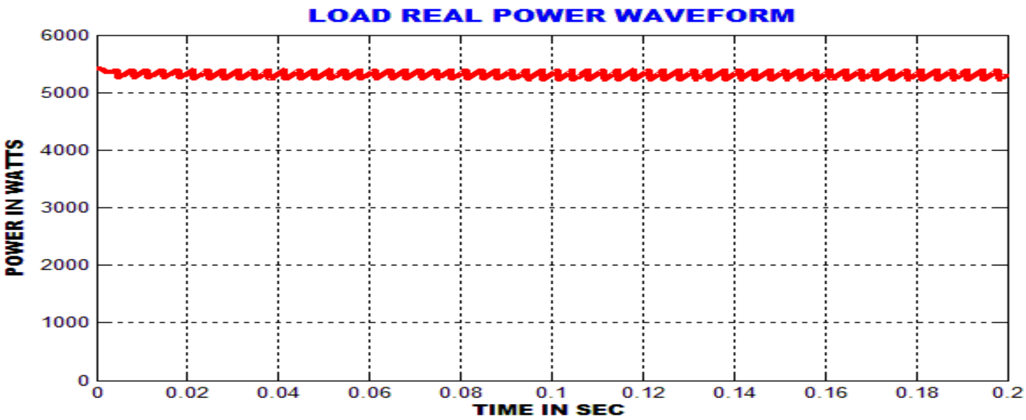

Figure 12: Load real power waveform

The figure 12 shows real power waveform in load side. The PI based compensation reduce the reactive power and increase the real power, also this system attains steady state voltage operation.

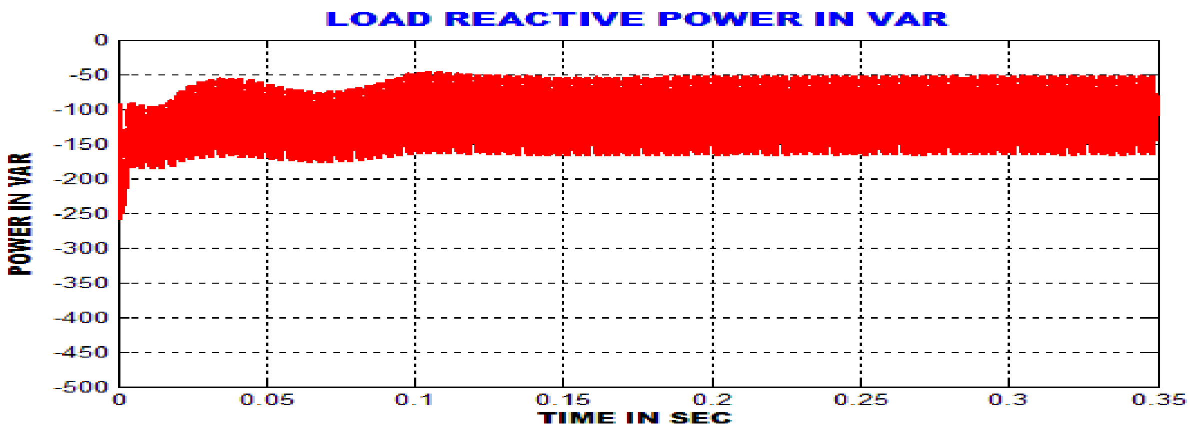

Figure 13: Reactive power waveform

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The figure 13 describes about the reactive power waveform obtained.

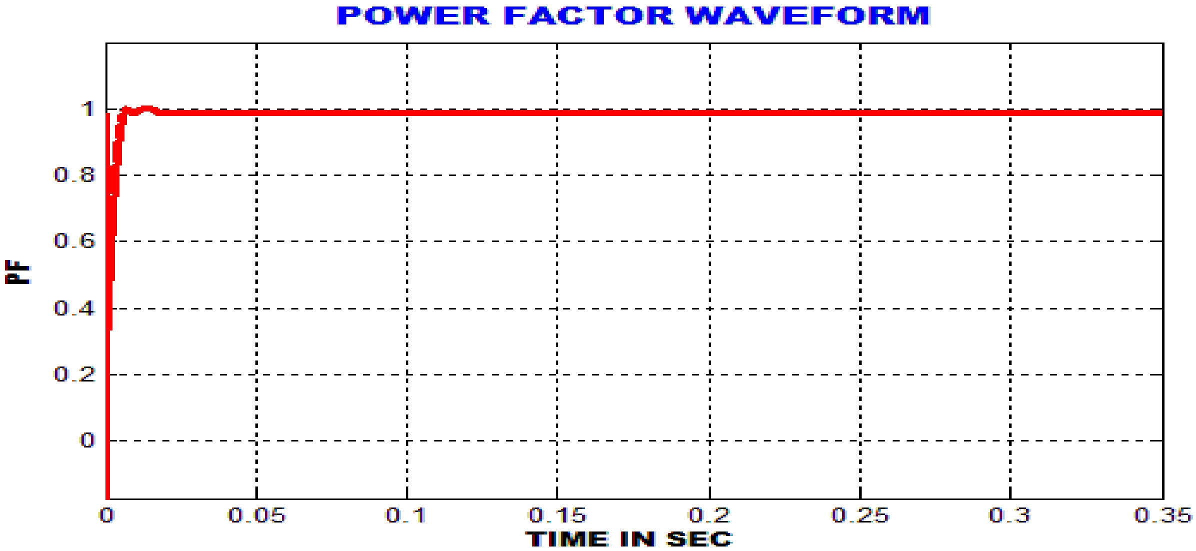

Figure 14: Power factor waveform

The figure 14illustrates the load side power factor waveform, the hysteresis current controller achieves grid synchronization, also maintains near unity power factor. PI controller makes real power as high compared to reactive power. Unity power factor operation reduce the power quality issues.

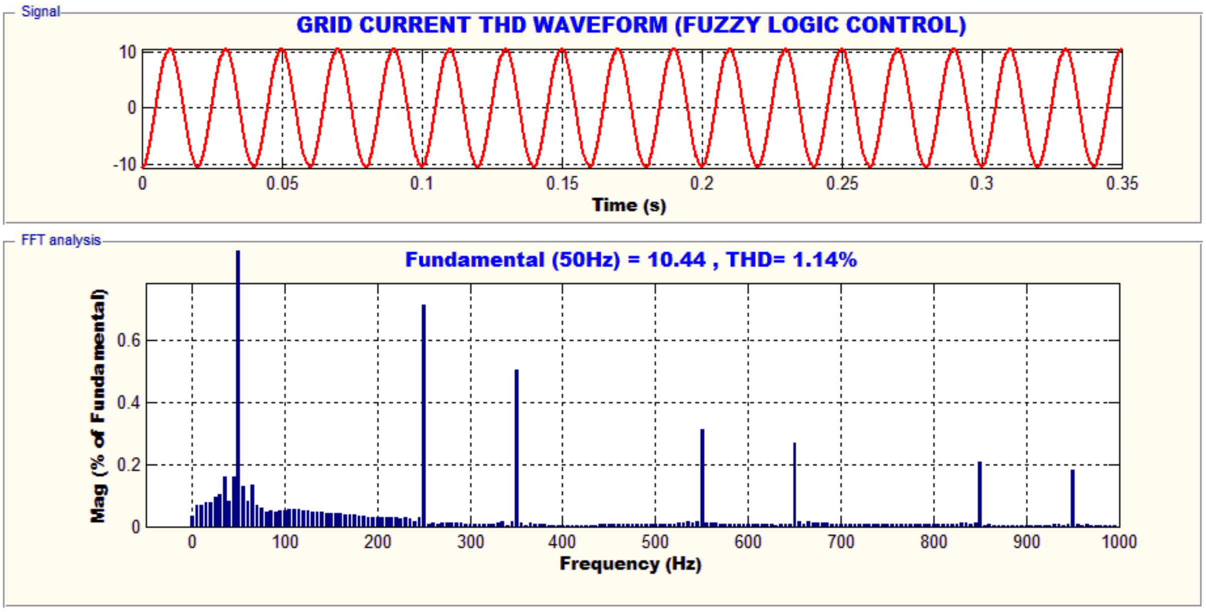

Figure 15: Grid current THD Waveform using fuzzy logic control technique

The THD value of the grid current is identified by using fuzzy logic control technique as obtained in the figure 15.

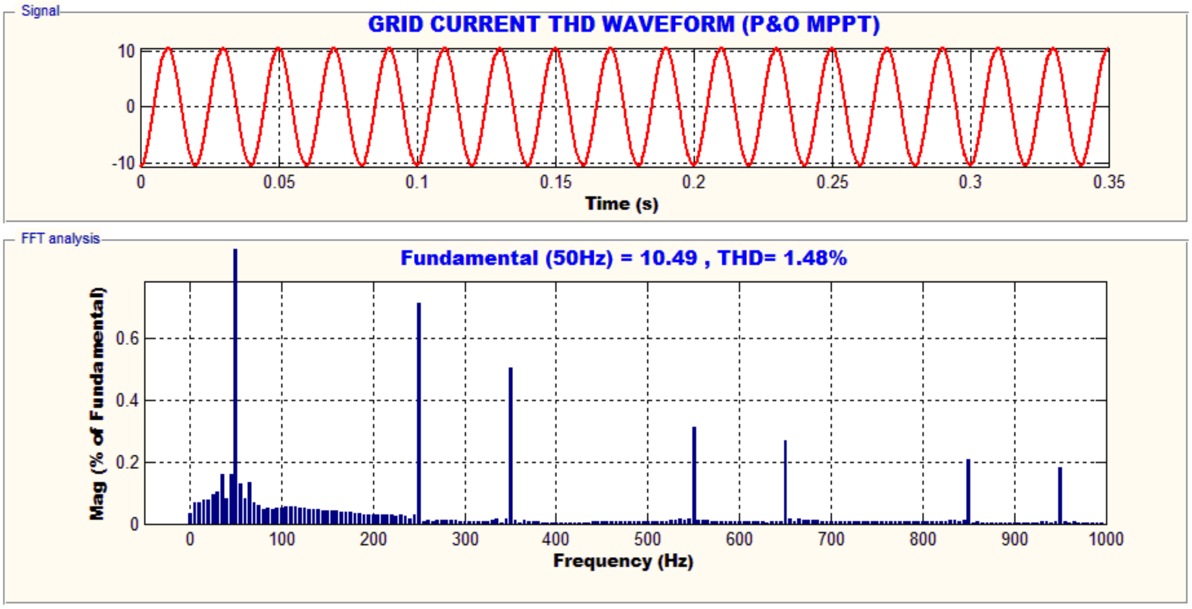

Figure 16: Grid current THD Waveform using P&O control technique

The figure 16displays the grid current THD waveform with FFT analysis and the PI based steady state voltage operation reduce the Total harmonics distortion. The Landsman converter based MPPT fuzzy logic algorithm excerptsextreme power from the PV system and also itpreserves constant voltage to the grid through three phase inverter. The proposed work reduce the power quality issues and also THD value of the grid current. The grid current THD fulfills the IEEE harmonics standard.

IV. Conclusions

The proposed modelinvolves the AC grid which feeds from the solar PV Renewable Energy Source. The purpose of the grid is to fulfill the load demand from the distribution side. The proposed micro-grid system is fed from RES is found fit for meeting load requirement of a far-flungremote location involving few households. FLC based MPPT is used to extract the maximum power from the solar PV system and then the controlled output is served to the switch present in the Landsman converter as a PWM signal from PWM generator. The suggested automated system model maintains the performance of the entire system irrespective of the environmental situations. The power feature of the system is maintained due to the steady power flow balanced by the battery storage system and the harmonics are reduced due to the LC filters present in the system. The proposed system acts as an Energy Management System as the power flow is smooth and continuous irrespective of the change in the input. This is the most effective method and it is proved by the test results taken. The future of the system can enhance with the hybrid renewable energy sources where wind energy system, biomass etc. like other sources can be added in addition in future for providing the most effective system. Instead of using Fuzzy Logic Controller MPPT based Algorithm, other standard and recent Controller can be implemented. The AC grid can be replaced by smart grid or microgrid or super microgrid in future as a trending change over.

References

1. Temitope Adefarati, Ramesh C. Bansal, Jackson John Justo, " Techno-economic analysis of a PV-wind-battery-diesel standalone power system in a remote area", The Journal of Engineering, vol. 2017, Iss. 13, pp. 740-744, doi: 10.1049/joe.2017.0429.
2. V.Karthikeyan,Rajesh Gupta, " Varying Phase Angle Control in Isolated Bidirectional DC-DC Converter for Integrating battery storage and

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ISSN: 0193-4120 Page No. 180 - 193

solar PV system in standalone mode", IET, 2017,Vol. 10, Iss. 4, pp. 471-479.

3. Nupur Saxena, Bhim Singh, Anoop Lal Vyas, " Single – phase solar PV system with battery and exchange of power in grid connected and standalone modes", IET Renew. Power Gener., 2017, Vol.11 Iss.2, pp. 325 – 333.
4. Miloud Rezkallah, Sanjeev Singh, Ambrish Chandra, Bhim Singh, Marco Tremblay, Maarof Saad, Hua Geng, " Comprehensive Controller Implementation for Wind-PV-Diesel Based Standalone Microgrid", IEEE Transactions on Industry Applications,2019, DOI 10.1109.
5. Kamran Ali Khan Niazi, Yongheng Yang, Dezso Sera " Revew of mismatch mitigation techniques for PV modules", IET Renewable Power Generation, 2019, Vol. 13 Iss. 12, pp. 2035-2050.
6. Augustine M.Egwebe, Megdad Fazeli, Petar Igic, Paul Holland, "Implementation and stability study of Dynamic Droop in Islanded Microgrids" , IEEE Transactions on Energy Conversion,2016,DOI: 10_1109.
7. Bhim Singh, Shadab Murshid "A Grid Interactive Permanent Magnet Synchronous Motor Driven Solar Water Pumping System", IEEE Transactions on Industry Applications, 2018, DOI: 10_1109.
8. Venkatramanan D, Vinod John, " Dynamic Modelling and Analysis of Buck Converter based Solar PV Charge Controller for Improved MPPT Performance", IEEE Transactions on Industry Applications,2019, DOI: 10_1109."
9. Michael D'Antonio, Chuan Shi, Bin Wu,Alireza Khaligh"Design and Optimization of a Solar Power Conversion System for Space Applications",IEEE,2019.
10. Duy C. Huynh and Matthew W. Dunnigan, "Development and Comparison of an Improved Incremental Conductance Algorithm for Tracking the MPP of a Solar PV Panel", IEEE Transactions on Sustainable Energy, 2016, DOI:10.1109.
11. S.K. Tiwari*, Bhim Singh, P.K. Goel "Design and Control of Autonomous Wind-Solar System with DFIG Feeding 3-Phase 4-Wire Loads",IEEE Transactions on Industry Applications , 2017, DOI: 10.1109.
12. K. T. Tan, B. Sivaneasan, X. Y. Peng and P. L. So, "Control and Operation of a DC Grid-Based Wind Power Generation System in a Microgrid", IEEE Transactions on Energy Conversion, 2015, pp. 0885-8969.
13. Load Mohammad Masoud Namazi, Sayed Morteza Saghaian Nejad, Ahmadreza Tabesh, Amir Rashidi and Marc o Liserre, "Passivity-based Control of Switched Reluctance-based Wind System Supplying Constant Power", IEEE Transactions on Industrial Electronics, 2018, DOI: 10.1109.
14. Peng Kou, Deliang Liang, Junmin Wang and Lin Gao, "Stable and Optimal Load Sharing of Multiple PMSGs in an Islanded DC Microgrid", IEEE Transactions on Energy Conversion, 2017, DOI :10.1109.
15. Radha Kushwaha and Bhim Singh "Power Factor Improvement in Modified Bridgeless Landsman Converter Fed EV Battery Charger", 2019, IEEE Transactions on Vehicular Technology, DOI:10.1109.
16. Praveen Kumar Singh, Bhim Singh, Vashist Bist, Kamal Al-Haddad and Ambrish Chandra "BLDC Motor Drive Based on Bridgeless Landsman PFC Converter with Single Sensor and Reduced Stress on Power Devices", IEEE Transactions on Industry Applications, 2017, DOI:10.1109.
17. Geeta Pathak, Bhim Singh and B. K. Panigrahi "Back Propagation Algorithm Based Controller for Autonomous Wind-DG Microgrid", IEEE Transactions on Industry Applications, 2016, DOI:10.1109.

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18. Yinghao Shan, Jiefeng Hu, Ka Wing Chan, Qing Fu, and Josep M. Guerrero " Model Predictive Control of Bidirectional DCDC Converters and AC/DC Interlinking Converters – A New Control Method for PVWind-Battery Microgrids", 2018,IEEE Transactions on Sustainable Energy, DOI: 10.1109.
19. Yinghao Shan, Jiefeng Hu, Zilin Li, and Josep M. Guerrero "A Model Predictive Control for Renewable Energy Based AC Microgrids without Any PID Regulators", IEEE Transactions on Power Electronics, 2018, DOI: 10.1109.
20. Xiaonan Lu, Jianhui Wang, Josep M. Guerrero and Dongbo Zhao, "Virtual Impedance Based Fault Current Limiters for Inverter Dominated AC Microgrids", IEEE Transactions on Smart Grid, 2016,DOI:10.1109.
21. Tomislav Dragičević, Member, IEEE, Xiaonan Lu, Member, IEEE, Juan C. Vasquez, Senior Member, IEEE and Josep M. Guerrero, Fellow, IEEE, "DC Microgrids–Part II: A Review of Power Architectures, Applications and Standardization Issues", IEEE Transactions on Power Electronics, DOI:10.1109.
22. Seema Kewat , Bhim Singh, Ikhlaq Hussain, "Power management in PV-battery-hydro based standalone microgrid", IET Renewable Power Generation, 2018,doi: 10.1049, Vol. 12 Iss. 4, pp. 391-398.
23. Shailendra Kr. Tiwari, Bhim Singh, Puneet K. Goel, "Design and Control of Micro-Grid fed by Renewable Energy Generating Sources", IEEE Transactions on Industry Applications , 2018, DOI:10.1109.
24. Hua Han, Xiaochao Hou, Jian Yang, Jifa Wu, Mei Su, and Josep M. Guerrero, "Review of Power Sharing Control Strategies for Islanding Operation of AC Microgrids", IEEE Transactions on Smart Grid, 2015.
25. Bhim Singh, Fellow, IEEE, Geeta Pathak, Member, IEEE, B. K. Panigrahi, Senior Member, "Seamless Transfer of Renewable Based Microgrid between Utility Grid and Diesel Generator", IEEE Transactions on Power Electronics, 2017, DOI:10.1109.
26. Walid R. Issa, Ahmad H. El Khateb, Mohammad A. Abusara, and Tapas K. Mallick,"Control Strategy for Uninterrupted Microgrid Mode Transfer during Unintentional Islanding Scenarios",IEEE Transactions on Industrial Electronics, 2017, DOI:10.1109.
27. Rishi Kant Sharma and Sukumar Mishra, "Dynamic Power Management and Control of PV PEM fuel Cell based Standalone AC/DC Microgrid Using Hybrid Energy Storage", IEEE Transactions on Industry Applications , 2017,DOI:10.1109.