IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Hybridized Intelligent Home Renewable Energy Management System For Smart Grids

Dr. V. Thirumurugan[1].,M.E.,PhD.,HOD (Dep .of Electrical and Electronic Engineering)
The Kavery Engineering College , Mecheri.
C. Dharmaraj[2] , M.Gokul[3], P.Silambarasan[4], K.Maithamilan[5], 2,3,4,5 UG SCHOLAR
Dep. of Electrical and Electronic Engineering
The Kavery Engineering College ,Mecheri, Salem, Tamil Nadu, India.

Abstract:
Renewable energy systems such as photovoltaic (PV) and wind energy systems are widely designed grid connected or autonomous. This is a problem especially in small powerful system due to the restriction on the inverter markets. Inverters which are utilized in these kinds of energy systems operate on grid or off grid. In this study, a novel power management strategy has been developed by designing a wind-PV hybrid system to operate. The inverter used in this study has been designed to operate both as an autonomous system and as a grid-connected system on-grid and off-grid. Due to the continuous demand for energy, gel batteries are used in the hybrid system. The designed Power Management Unit performs measurement from various points in the system and in accordance with this measurement; it provides an effective energy transfer to batteries, loads and grid.

Keywords—MPPT, Hybrid Energy, Stand Alone System, Photovoltaic, Wind Energy, Power Management, perturbs and observes.

I INTRODUCTION

The constantly increasing consumption of energy, the exhaustible nature of fossil fuel and its ever increasing cost and global environment worsening have created interest in green power generation systems.

However, due to the random nature of the wind speed and solar radiation, the reliable power supply cannot be provided with only the use either a wind turbine generator (WTG) or a photovoltaic generator (PV) [2]. However, it can be improved by using a hybrid association of photovoltaic and wind systems, where the storage is the solution for standalone applications .

Moreover, In addition, numerous studies and economic analyzes have indicated that hybrid PV-wind and PV-wind-diesel systems with or without battery backup for power generation are now considered cost-effective technologies.

The major limitation for these hybrid systems is the control requirement for optimal efficiency. For that, the control systems used a maximum power point tracking (MPPT) control algorithm to track the maximum available power from the high penetrating renewable sources (PV-wind).

In Solar conversion system, MPPT is achieved with the DC to DC converter which operates PV module at its maximum power point by using the conventional algorithms such us P&O (Perturb and Observe) and incremental conductance algorithm. This algorithm may fail to track the point of maximum power since performance depends largely on the choice of the perturbation size value used. The value of this disturbance is usually calculated by testing and / or simulation tests [5].

In order to improve energy conversion efficiency of the photovoltaic generator, this paper presents a comparative study between an classical method of maximum power point tracking (MPPT) and improvement of classical one , under various climatic conditions. Also, the power management strategy that enhances the hybrid system performance by introducing battery charging and discharging limit control, load priority setting and secondary load control is discussed. This proposed strategy has been implemented on a PV-wind hybrid energy system model with battery backup.

II MODELING OF HYBRID SYSTEM

The hybrid scheme with wind turbine and photovoltaic system, doubly fed induction generator models proposed is presented in this section.

A. Wind turbine modeling

Wind turbines convert the kinetic energy present in the wind into mechanical energy by means of producing torque. Since the energy contained by the wind is in the form of kinetic energy, its magnitude depends on the air density and the wind velocity. The wind power developed by the turbine is given by the equation (1)

$$P_w = \frac{1}{2} C_p A v^3 (01)$$

Where Cp is the Power Co-efficient, ρ is the air density in kg/m3, A is the area of the turbine blades in m2 and v is the wind velocity in m/sec. The power coefficient Cp gives the fraction of the kinetic energy that is converted into mechanical energy by the wind turbine. It is a function of the tip speed ratio λ and depends on the blade pitch angle for pitch-controlled turbines. The tip speed ratio may be defined as the ratio of turbine blade linear speed and the wind speed

$$\lambda = \frac{R\omega}{V}$$

Substituting (2) in (1), we have:

$$P_w = \frac{1}{2} C_P(\lambda)\rho A \left(\frac{R}{\lambda}\right)^3 \omega^3$$

The output torque of the wind turbine is calculated by the following equation (4).

$$T_{turbine} = \frac{1}{2} C_P \rho A V/\lambda$$

Where R is the radius of the wind turbine rotor (m) There is a value of the tip speed ratio at which the power coefficient is maximum [1]. Variable speed turbines can be made to capture this maximum energy in the wind by operating them at a blade speed that gives the optimum tip speed ratio. This may be done by changing the speed of the turbine in proportion to the change in wind speed.

B. Photovoltaic array model

Fig.1 shows the equivalent circuit of photovoltaic (PV) cell. A PV cell can be represented by an equivalent circuit [9] as shown in Figure 1. The characteristics of this PV cell can be obtained using standard equation (06).

$$I = I_{pv} - I_0\left[e^{\left(\frac{V+R_sI}{V_t a}\right)} - 1\right] - \frac{V+R_sI}{R_p}$$

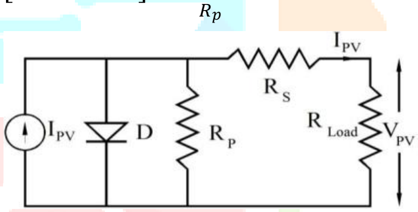

Fig. 1. Equivalent circuit of PV cell

I_{PV} = photovoltaic current
I_O = saturation current
$V_t = N_S\, k\, T/q$, thermal voltage of array
Ns = cell connected in series
T = is the temperature of the p-n junction
k = Boltzmann constant
q = electron charge
R_S, R_P = equivalent series/ parallel resistance of the array

The general equation of a PV cell describes the relationship between current and voltage of the cell.

Since the value of shunt resistance RP is high compared to value of series resistance RS the current through the parallel resistance can be neglected. The light generated current of the photovoltaic cell depends linearly on the solar irradiation and is also influenced by the temperature [10] given by the equation .

$$I_{pv} = [I_{pv,n} + K_I \Delta_T]\frac{G}{G_n}$$

I_{PV}= is the light generated current at nominal condition (250C and 1000 W/ m2)

$$\Delta T = T - T_n$$

T ,Tn= actual and nominal temperature [K]
K_I = current coefficients
G = irradiation on the device surface [W/m2]
G_n = nominal irradiation

The current and voltage coefficients KV and KI are included as shown in equation (11) in order to take the saturation current IO which is strongly dependent on the temperature.

$$I_o = \frac{I_{sc,n} + K_I\Delta_T}{e^{\left(\frac{V_{oc,n}+K_V\Delta_T}{aV_t}\right)} - 1}$$

K_V = voltage coefficients
K_I = current coefficients

TABLE I. Parameter of KPC-12075 solar array at 25°c,1000W/m2Table

I_{mp}	4.40 A	V_{oc}	21.20
V_{mp}	17.00 V	a	1.3
P_{max}	74.8 W	R_{sc}	0.511 Ω
I_{sc}	5.02 A	R_{sh}	44.25 Ω
N_s	36	K_v	-74.7 mv/°C
$I_{0,n}$	9.83 x 10^{-8}	K_I	2.80 mA/°C

C. Doubly-fed induction generator dynamic model

The application of Concordia and Park's transformation to the three-phase model of the DFIG permits to write the dynamic voltages and fluxes equations in an arbitrary d–q reference frame:

$$\begin{cases} V_{ds} = R_s I_{ds} + \frac{d\varphi_{ds}}{dt} - \omega\varphi_{qs} \\ V_{qs} = R_s I_{qs} + \frac{d\varphi_{qs}}{dt} + \omega\varphi_{ds} \\ V_{dr} = R_r I_{dr} + \frac{d\varphi_{dr}}{dt} - \omega\varphi_{qr} \\ V_{qr} = R_r I_{qr} + \frac{d\varphi_{qr}}{dt} + \omega\varphi_{dr} \end{cases}$$

$$\begin{cases} \varphi_{ds} = L_s I_{ds} + M I_{dr} \\ \varphi_{qs} = L_s I_{qs} + M I_{qr} \\ \varphi_{dr} = L_r I_{dr} + M I_{ds} \\ \varphi_{qr} = L_s I_{qr} + M I_{qs} \end{cases}$$

The stator and rotor angular velocities are linked by the following relation:

$$\omega_s = \omega + \omega_r$$

Where the electromagnetic torque c e can be written as a function of stator fluxes and rotor currents:

$$\Gamma_e = p\frac{M}{L_s}(\varphi_{qs} I_{dr} + \varphi_{ds} I_{qr})$$

DC – DC BOOST CONVERTER

A dual stage power electronic system comprising a boost type dc-dc converter and an inverter is used to feed the power generated by the PV array to the load. To maintain the load voltage constant a DC-DC step up converter is introduced between the PV array and the inverter. The block schematic of the proposed scheme is shown in Fig. 2.

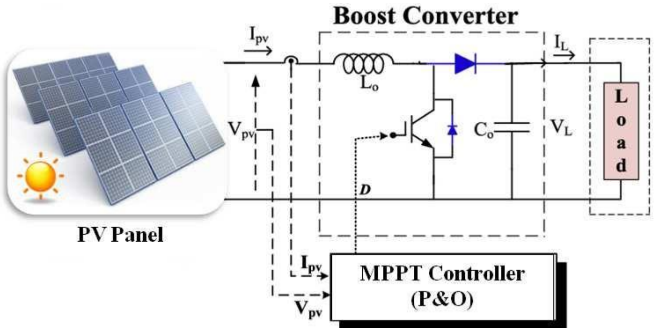

Fig. 2. A MPPT Controller in a PV System

In this scheme a PV array feeds DC-DC converter used in step-up configuration. For a dc-dc boost converter, by using the averaging concept, the input–output voltage relationship for continuous conduction mode is given by:

$$\frac{V_o}{V_{in}} = \frac{1}{(1-D)}$$

Where, D = duty cycle.

The control of hybrid system

In this section the strategy of controls of the photovoltaic system and the DFIG are discussed.

A. Control strategy of DFIG

By choosing a reference frame linked to the stator flux, rotor currents will be related directly to the stator active and reactive power. An adapted control of these currents will thus permit to control the power exchanged between the stator and the grid. If the stator flux is linked to the d-axis of the frame we have:

$$\phi_{ds} = \phi_s \text{ and } \phi_{qs} = 0$$

and the electromagnetic torque can then be expressed as follows:

The active power and consequently the torque depend on the rotor current component of the q-axis. If the statorique resistance per phase is neglected, which is a realistic approximation used in wind energy conversion, the statorique vector voltage is in quadratic:

The stator voltages are

$$V_{ds} = 0 \text{ and } V_{qs} = V_s = \omega_s \phi_s$$

Using Esq. (13), (16) and (17) the stator active and reactive power can then be expressed only versus these rotor currents as:

$$\begin{cases} P = V_s I_{qs} = -V_s \frac{M}{L_s} I_{qr} \\ Q = V_s I_{ds} = \frac{V_s \phi_s}{L_s} - \frac{V_s M}{L_s} I_{qr} \end{cases}$$

In steady state, the second derivative terms of the two equations in are nil. The third term, which constitutes cross-coupling terms, can be neglected because of their small influence. Knowing relations (11) and (18), it is possible to synthesize the regulators and establish the global block-diagram of the controlled system (Fig. 3).

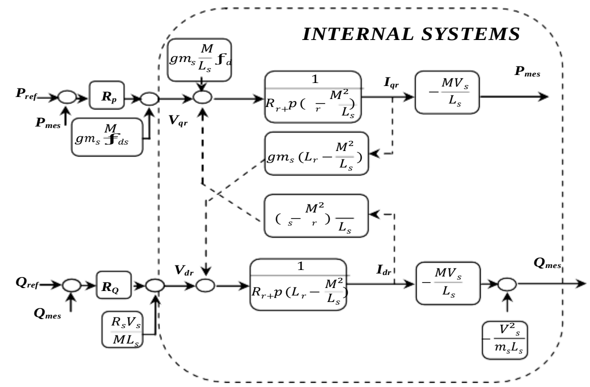

Fig. 3. Block-diagram of the controlled system

B. Control strategy of photovoltaic system

Several MPPT control algorithms in which the classical algorithms are the technique of perturbation and observation (P & O) and the technique of incremental conductance where they have been developed in many research works. This work involves applying amodified perturbation and observation (P & O) as an MPPT method for PV system control.

B.1 ALGORITHM PERTURBAR AND OBSERVE (P&O)

The algorithm, based on the characteristic curves of Figure 4, is a perturbation and observation method in which a small increase in voltage or current is applied and the power variation is verified. In case of increase of the power supplied by the panel, the algorithm follows with perturbations in the same direction. However, in case of power decrease, in the next iteration the disturbance will happen in the opposite direction. Thus, the P&O algorithm causes the reference to vary by values close to MPP.

For the algorithm to have a good efficiency it is important to make a proper choice for perturbation increment (dV). It is important that dV does not assume a very small value, so it takes time for the algorithm to find MPP. Nor should it assume very large values, as it will result in large variations around MPP.

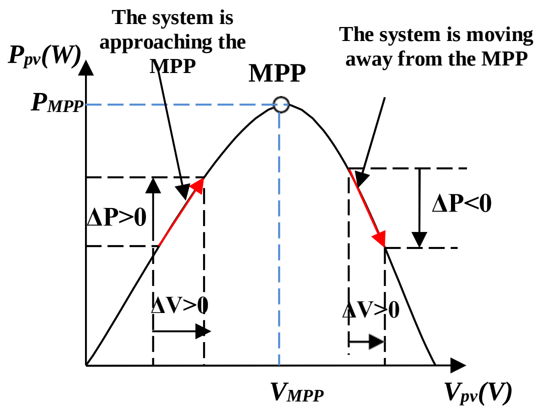

Fig. 4. Illustration of the MPPT control the type « P&O ».

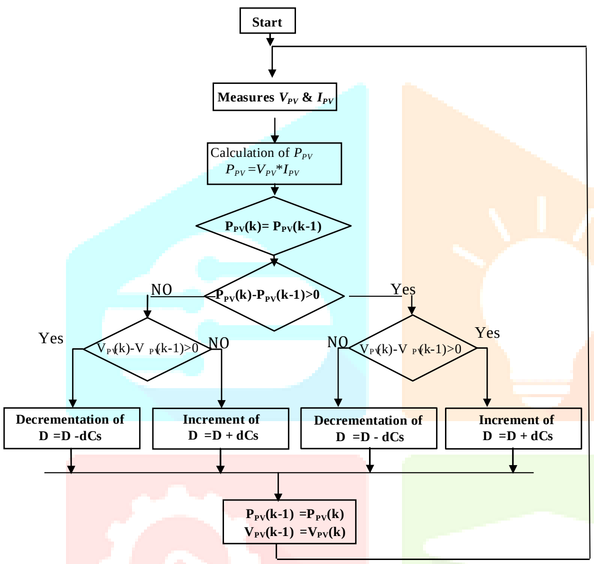

Fig. 5. Flowchart of classical perturb and observe (p&o)algorithm.

B.2 Modification of the traditional P&O control algorithm

The modified P&O algorithm is presented in Figure 6, where a useful cycle value of 50% is defined, which corresponds to a theoretical value approximated to the MPP under ideal conditions, this to decrease the establishment time. With respect to the oscillation in the MPP, an alternative is proposed to decrease this oscillation, in the test of classical P &O algorithm we found that the system stabilizes in the MPP and begins to oscillate; this oscillation is in the 900mW range, for each disturbance which is done every 10ms. According to the above, a change in the algorithm is proposed that allows the size of the disturbance to be adapted, that is, now the size of the disturbance varies depending on whether the system is in the MPP or if it is in the search for the MPP.

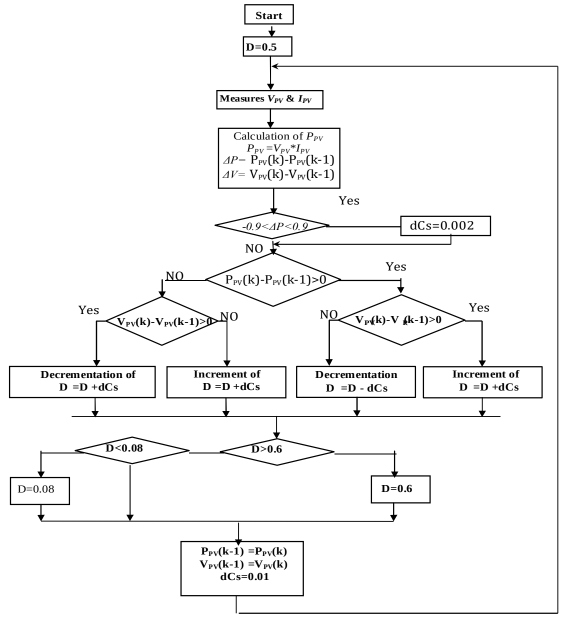

Fig. 6. Flowchart of the modified perturb and observe (p&o)algorithm.

HYBRID POWER MANAGEMENT STRATEGY

To operate the stand alone PV-wind hybrid energy system a customized control strategy is implemented ensuring higher reliability of this system under different atmospheric conditions. The control strategy proposed is developed based on the state of charge (SOC) of the batteries which includes AC and DC load control, secondary AC and DC load control during higher generation and most importantly the battery charge and discharge limit control. The proposed control, subdivided into five different stages, considers all possible operating conditions to run a hybrid system efficiently and reliably under different weather conditions. The block diagram representation of the suggested control strategy is shown in Fig. 7. The major five control stages are: Initialization , Normal operating condition, Lower limit of battery SOC control (High load or low generation), Upper limit of battery SOC control (Low load or high generation) and Wind energy extreme case control.

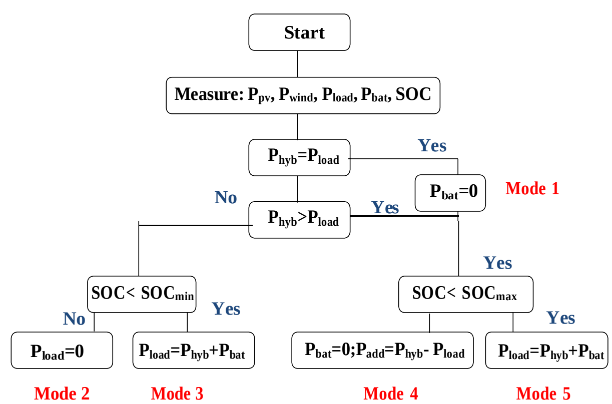

Fig. 7. Block diagram representation of the diagram of the managementstrategy

SIMULATION RESULTS

The dynamic simulation model for the system is described. The system consists of various units, PV power and wind power units as primary sources of energy, battery bank unit as auxiliary source of energy, dc-dc and dc-ac converters, load unit and control unit. The function of controller unit is to ensure the management of the power, which is delivered by the hybrid system to satisfy the load and to charge the battery. The inverter unit is used to convert the DC generated power from renewable energy sources to feed the load with the required AC power. The excessive charge from the battery will be dumped to the dump load unit. The dump load in this case is the battery storage figure 8.

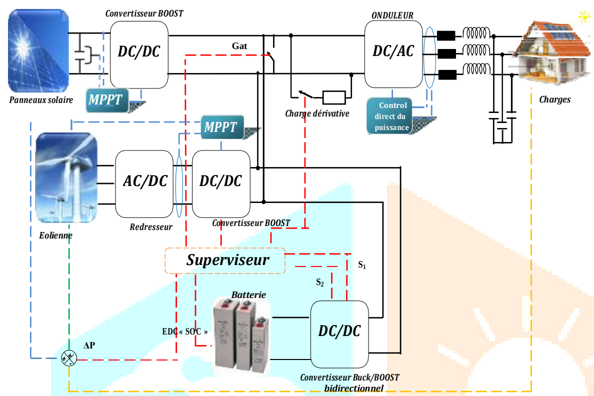

Fig. 8. Block diagram representation of PV-Wind Hybrid power systemwith supervisor

In Figure.9 we can see the two characteristics (I-V) and (P-V) with the application of two techniques to maximize the power of panels through a boost converter. The first is the classical P&O where the system stabilizes in the MPP and begins to oscillatebrusquely,unlike the modified algorithm thesystem is stable.

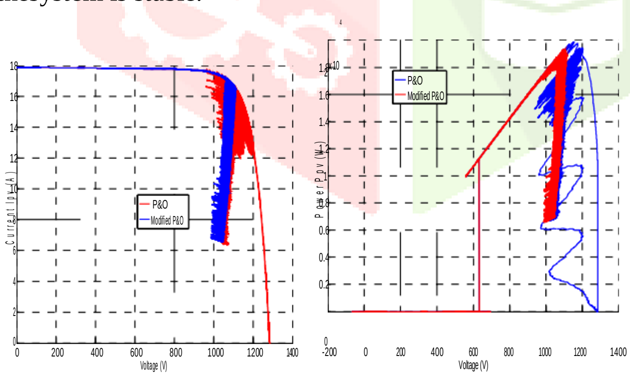

Fig. 9. (I-V) and (P-V) MPPT characteristics

Figure.10 and 11 shows respectively that the output voltage of the photovoltaic panel is well controlled to follow the optimal value according to the variation of the sunlight and the load, and while the panel always produce a maximum power under all conditions. Our controller has optimized the production of the photovoltaic system.

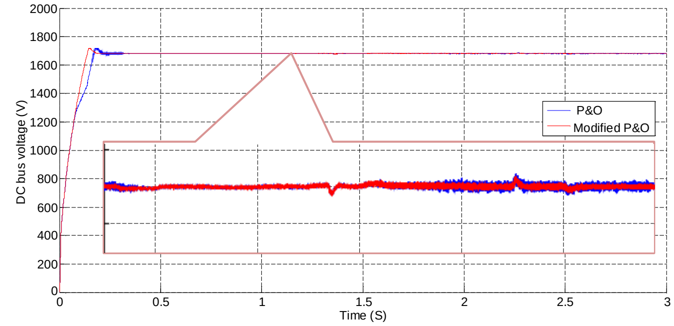

Fig. 10. DC bus voltage.

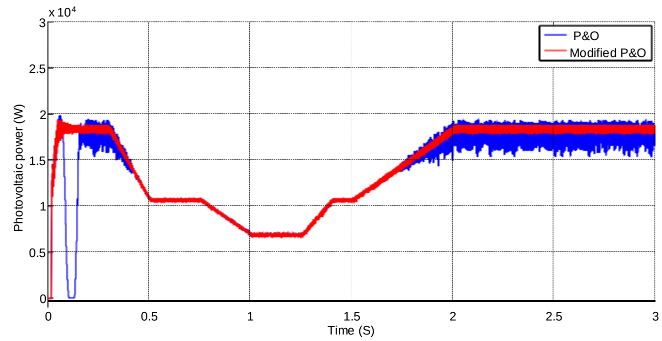

Fig. 11. Power of the PV Panel

The report named "Gate" is controlled to ensure proper operation of the converter "bidirectional chopper" voltage applied to the battery.

Until the moment of 1.5 s, the climatic conditions deteriorate "a kiss of the sunshine with a weak wind", but the requested power remains in surplus the battery is discharged (S1 = 1) because the load request exceeds the renewable power, and when this power is sufficient, the battery will be deactivated (S2 = 1) in order to use all the renewable power produced
(figure 13).

In the case where the load power exceeds the power supplied, the battery must compensate for this difference.
In the 1 seconds to the 1.5 seconds, the wind speed increases, at the same time the load demand decreases, the surplus becomes too big (Ppv + Peel-Pdem = 3.2 kW), then to avoid the gaseous release of the battery, the load shed resistance is switched on (Gate = 1) to dissipate the excess energy figure 12.
The voltage quality is always respected (f = 50Hz, V = 380V) in all climatic and operating conditions.

These simulations show that our controller has good results. It has load demand, despite the variations in weather conditions, with good power while respecting the charging process of the battery. Other simulations with other more or less important variations made it possible to verify these good results.

Figure 13 shows the power generated and the power consumed as well as the power of the battery for both algorithms, the classic and modified algorithm of P & O, where we find thatthe second one offers a better pursuit.

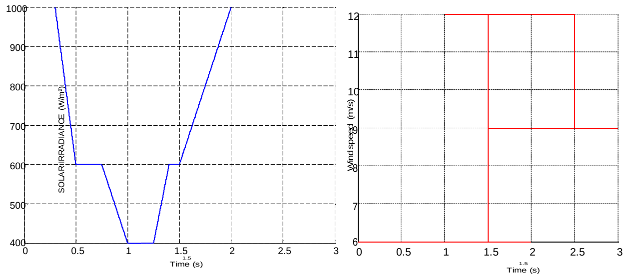

Fig. 12. Wind speed and solar irradiance variation and load

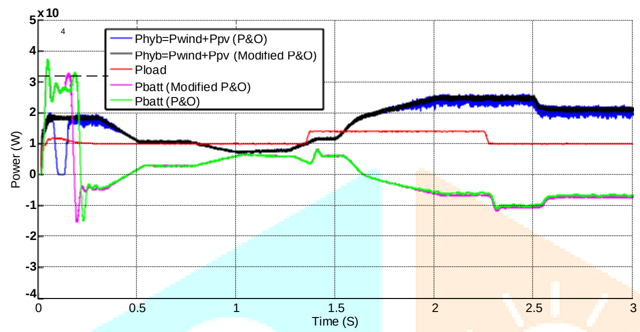

Fig. 13. Renewable power, battery power and load power

CONCLUSION

An MPPT controller was discussed in this paper using the P&O control algorithm, which allows us to track and control the maximum power point of a photovoltaic panel, this controller extracts the maximum energy from a solar panel without depending on the specific characteristics of the type of panel used, such as It also does not depend on the conditions of irradiance, temperature and charge. This algorithm shows deficiencies in the convergence time and oscillations in the MPP, in order to overcome these deficiencies, the traditional P&O algorithm was modified, where the 50% work cycle was initialized, this to reduce the time of convergence to the MPP, on the other hand, to decrease the oscillations in stable state, a dynamic step size is raised, in this way it is possible to eliminate the oscillations notoriously and the convergence time is faster.

Alsothe hybrid power management strategy is developed to control the power flow of the system and maintain battery charging and discharging limits under any operating conditions.

We have introduced a power generation system for sites that cannot be connected to the grid. Indeed, we used a continuous bus which receives the energy produced by the photovoltaic and wind power sources and then delivered to the consumer using an inverter. One of the advantages of this structure is the use of the necessary batteries in case of need to compensate for a possible lack of power. We have also used a load shedding resistor which allows dissipating the surplus energy in the event of a drop in demand and full batteries.

To have optimal behavior of the installation from a power flow point of view, we have developed a supervisor or. It enables efficient and rational energy management to meet the energy needs of the consumer. Several simulation results have been presented to illustrate the performance of our facility in the presence of climate change and changes in energy consumption.

Based on the above analysis, it can be concluded that the proposed hybrid scheme offers a reliable and alternative solution of renewable energy to meet the increasing power demand, overcoming any intermitting challenges and allowing widespread development of such systems especially in locations where no grid is available.

REFERENCES

[1] Yazhou Lei, Alan Mullane, Gordon Lightbody, and Robert Yacamini, “Modeling of the Wind Turbine With a Doubly Fed Induction Generator for Grid Integration Studies,” IEEE Energy Conversion, vol. 21, pp. 257–264, Mar. 2006.

[2] Iqbal Messaïf , El-Madjid Berkouk , Nadia Saadia “A Study of DTC-Power Electronic Cascade Fed by Photovoltaic Cell-Three-Level NPC Inverter” Smart Grid and Renewable Energy, 2010, 1, 109-118

[3] Vijayalakshmi.R , Mr. A. Nazar Ali. M.E, “Hybrid power generations (Wind/Solar by PV) – An efficient output with reduced total harmonics distortions using multi level inverter” International Journal of Communications and Engineering Volume 04– No.4, Issue: 04 March 2012.

[4] G. Balasubramanian and S. Singaravelu “Fuzzy logic based controller for a stand-alone hybrid generation system using wind and photovoltaic energy” International Journal of Advances in Engineering & Technology, May 2012. ISSN: 2231-1963

[5] Jain, S.K.; Agrawal, P.; Gupta, H.O.; “Fuzzy logic controlled shunt active power filter for power quality improvement” IEE Proceedings-Electric Power Applications, Volume 149, Issue5, Sept.2002 Page(s):317 -328.

[6] T. Esram and P. L. Chapman, “Comparison of photovoltaic array maximum power point tracking techniques,” IEEE Transactions on Energy Conversion, vol. 22, no. 2, pp. 439–449, .

[7] T. boutabba, S. DRID, L CHRIFI-ALAOUI, Driss Mehdi, M.H. Benbouzid, Abdelaali Alibi, mohammed ouriagli, «dSPACE Real-Time Implementation of Sliding Mode Maximum Power Point Tracker for Photovoltaic System” 7th International Conference on Systems and Control ICSC 2018, València, Spain during October 24-26, 2018.

[8] M. A. Elgendy, B. Zahawi y D. J. Atkinson, «Assessment of Perturb and Observe MPPT Algorithm Implementation Techniques for PV Pumping Applications,» IEEE TRANSACTIONS ON SUSTAINABLE ENERGY, vol. III, nº 1, pp. 21-32, 2012.

[9] Boutabba Tarek, Drid said and M.E.H. Benbouzid, “Maximum Power Point Tracking Control for Photovoltaic System Using Adaptive Neuro- Fuzzy “ANFIS”” 2013 Ecological Vehicles and Renewable Energies (EVER), 8th International Conference and Exhibition on Ecological Vehicles and Renewable Energies (EVER), Monaco and IEEE.

[10] Boutabba Tarek, Drid said and M.E.H. Benbouzid, “A Multi-output Boost Converter (MOB) controlled by Fuzzy Logic Technique supplied by a Photovoltaic System with Grid-Connected and fed by three level inverter” November, 10-11, 2014, International Conference on Electro-Energy ICEE’14, Skikda, Algeria.

[11] Tarek Boutabba, Said Drid and M.H. Benbouzid, “A Hybrid Power Generations System (Wind Turbine/Photovoltaic) to Driving a DFIG fed by a Three inverter” STA'2014, the 15th international Conference on Sciences and Techniques of Automatic control & computer engineering, Hammamat Tunisia.

[12] T. Boutabba, S. Drid, L. Chrifi-Alaoui, M. Ouriagli and M.E.H. Benbouzid, « dSPACE real-time implementation of maximum power point tracking based on ripple correlation control (RCC) structure for photovoltaic system” 2016 IEEE ICSC At: Marrakesh (Morocco) Volume: pp. 371–376.