PSO-MPPT integrated with back stepping and fuzzy inverter control in Hybrid Energy Grid System for DC Voltage and Power Improvement

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Abstract: The use of renewable energy sources has increased rapidly over the past decade for a variety of reasons, including the decline in conventional energy sources, environmental concerns and the spread of fossil fuel prices. One of the most promising renewable energy sources are solar-based photovoltaic (PV) panels. However, due to their low efficiency and high costs, photovoltaic systems still face major challenges compared to conventional energy resources. Nut there is need to extract maximum power from the PV cells to meet the requirement as well as to make such system economical. For this maximum power point (MPP) control system for the photovoltaic generator is applied. In addition, MPP tracking (MPPT) is desirable in grid-connected and autonomous photovoltaic systems, as solar radiation and temperature also change throughout the day, according to the seasons and geographical conditions. In this work a hybrid model is simulated connected with grid to supply the demand of energy. The controller for MPPT is optimized using particle swarm optimization with backstepping control to reduce the fluctuation of voltage supply and to provide continuous power to the grid system. The fuzzy controller is applied in inverter control for improving system's performance.

Keywords: **Renewable Energy system, PV Array, Wind System, Fuel Cell, PSO-MPPT Charge Controller, DC/DC Converter, Fuzzy Controlled Inverter, Grid System.**

I. INTRODUCTION

Over the next few years, the world is expected to face several challenges related to the depletion of some energy sources, particularly those related to fossil fuels. It is also known that some aspects of the rise in the price of oil due to economic and political problems have been at the origin of the economic crisis of recent decades [1]. Because of this importance, the need for new energy sources is more necessary. The renewable energy source is the only solution to the problem such as pollution, which is the main reason for global warming. Since they are permanent and environmentally friendly for these reasons, research on the use of this energy has been on the rise for days. However, the technology has not yet reached its level to be considered competitive for fossil fuels. The energy analysis of solar energy, battery and diesel is discussed in this article. The main advantage of using renewable energy is the inexhaustible source of energy and the environmentally friendly nature. The main disadvantage is the lack of consistency. To overcome this drawback, it is possible to develop an autonomous hybrid system to efficiently use solar energy and also to reduce pollution caused by the diesel generator.

The search for renewable energy sources as a driving alternative to contain the global energy crisis will therefore become increasingly intense. Among clean and environmentally friendly energy sources, photovoltaic (PV) solar energy is an attractive alternative to complement electricity generation [2]. The considerable cost reduction of photovoltaic modules in recent years has made the use of solar energy particularly interesting, especially in small single-phase residential systems connected to the electricity grid and in stand-alone applications [3]. Electricity can be obtained by converting light directly into electricity, which is the photovoltaic effect. Furthermore, solar energy is freely usable, abundant in nature and respectful of the environment and plays a fundamental role in relation to the existence of all primary energy sources on earth [4, 5]. Despite all of the above, the conversion efficiency is low and the initial cost is still evident as MPPT techniques must be used to maximize the extracted energy. It is important to underline that taking into account the temperature and the irradiation, there is only one MPP for each curve.

In practice, a solar module consists of several solar cells connected in series and / or in parallel. If some cells in the panel are shaded, which is sometimes caused by surrounding buildings, clouds in the sky or birds landing on the solar panels, the solar photovoltaic panel is very complicated because the characteristics of the photovoltaic have several points such as maximum power tracking [6]. Autonomous solar and photovoltaic systems are currently subsidized on a relatively larger scale around the world. These independent systems cannot provide a continuous source of energy because they are seasonal. For example, an independent photovoltaic solar system cannot provide reliable electricity on non-sunny days.

Due to the constant fluctuations in the amplitude of the wind speed, the independent wind turbine cannot meet the constant load demands by the hour throughout the year. Therefore, energy storage systems are required for each of these systems to meet the performance requirements. Typically, the storage system is expensive and its size must be minimized for the renewable energy system to be sustainable. With hybrid drive systems, the need for energy storage can be reduced.

II. RELATED WORK

In practice, the voltage dependency on the irradiation is often neglected. As the effect on both the current and voltage is positive, i.e. both increase when the irradiation rises, the effect on the power is also positive. More the irradiation, the more power is generated. PV panel manufacturers provide in their data sheets the temperature coefficients, which are the parameters that specify how the open circuit voltage, the short circuit current and the maximum power vary when the temperature changes. As the effect of the temperature on the current is really small, it is usually neglected [10].

Eltamaly et al. [1] proposed a novel strategy for scanning the new position of the GP in case of PSC changes without a need for reinitialization. The proposed strategy sends a particle to the anticipated places of peaks to search for any peak with power greater than the current GP and when it locates this new GP it will move the PSO particles directly to the new GP. This strategy reduced the reinitialization time by 650% as compared to the time required for the random reinitialization of the conventional PSO technique. Moreover; this proposed strategy completely avoids the premature convergence associated with conventional PSO techniques.

Hadi Sefidgar et al. [9] suggested fuzzy logic control (FLC) to monitor the maximum power (MPPT) when connecting the wind turbine to the permanent magnet synchronous generator (PMSG). The proposed fuzzy controller tracks the maximum power point (MPP) by measuring the charge voltage and charge current. This command calculates the power of the load and is sent via the fuzzy logic system. The main objective of this work is the design of the fuzzy logic controller in the DC / DC converter model (Boost converter). This method allows the output of the MPPT (duty cycle) controller to adjust the frequency converter input voltage to keep track of the maximum power point of the wind turbine.

BUT. Abdullah et al. [14] examined the state of the available Maximum Power Point Tracking (MPPT) algorithms. Due to the type of wind that changes instantaneously, it is therefore only desirable to have an optimum generator speed that ensures at a given instant that the maximum available wind energy is obtained. It is therefore important to integrate a control system capable of following the maximum peak regardless of the wind speed. The available Maximum Power Point Tracking (MPPT) algorithms can be classified according to control variables and the technology used to identify the maximum peak. A comparison of the performance of the selected MPPT algorithms was made based on the different speed responses and the ability to achieve maximum energy efficiency.

Y. Xia et al. [15] proposed a new maximum power point detection method for a wind energy conversion system based on a permanent magnet synchronous generator. The technique searches for the optimal system relationship for tracking the maximum credit points and then checks the system against this relationship. The validity of the technology is theoretically analyzed and the design process is presented. The main advantage of the proposed technique is that it does not require an anemometer or prior knowledge of a system, but reacts accurately and quickly to changes in wind speed. In addition, changes in the time-dependent parameters of the turbines or generators can be updated.

III. METHODOLOGY

A. *Case 1: Wind-Solar Grid System*

In this research work, a wind-solar hybrid system connected to the grid for renewable energy is simulated and analyzed. The general block diagram of the system under consideration is shown in Fig.3.2. A conventional inverter is used to connect the renewable energy system to the grid. In this case, the inverter functions not only as an interface system for the actual flow of electricity to the grid, but also as a device for improving the quality of electricity. The control methods used in the system play an important role in the performance of the inverter. Photovoltaic and wind systems generate a DC output voltage. Different electronic power supply interfaces are required to connect these two sources to the network. In this thesis the hybrid photovoltaic / wind DC shunt system connected to the grid is used. In the system under consideration, the output of the DC sources is connected to a DC / DC step-up converter and the intermediate circuit voltage is regulated. The wind turbine output AC voltage is rectified in the first step using an unregulated rectifier, then a DC / DC boost converter is used to control the intermediate circuit voltage.

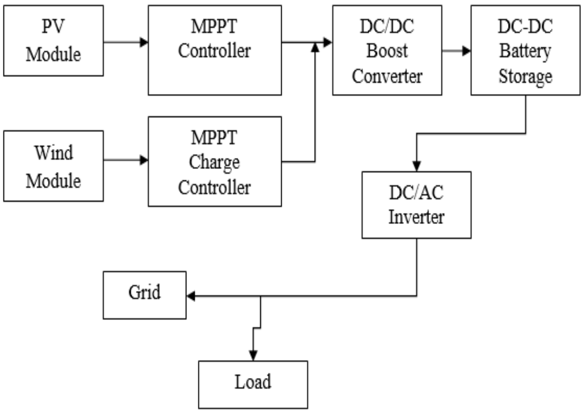

Figure 1: Block diagram of Scenario I (Solar-Wind RE System)

B. *Case 2: PSO-MPPT and PI Inverter Controller for Hybrid Grid System*

In this research, a grid-connected hybrid renewable energy system is simulated and analyzed. The general block diagram of the system under consideration is shown in Fig. 3.3. The system consists of a solar panel, a wind system and a fuel cell system with particle swarm optimization with charge controller to track the point of maximum power, battery packs, an AC / DC converter (the output voltage can be changed) and PI controller to improve performance. In this system the load was powered with direct current and not alternating current. B. Grid synchronization, which requires information on the phase angle of the grid voltage to transmit the power of the converters. In this study, the photovoltaic system created consists of a single conversion phase in which the photovoltaic generator is connected directly to the inverter connected to the grid. The algorithm used to perform MPPT is based on the PSO method. In other words, the proposed PSO-MPPT technique is used to track the global maximum power point (GMPP) of the PV system as these improve the overall performance of the PV system.

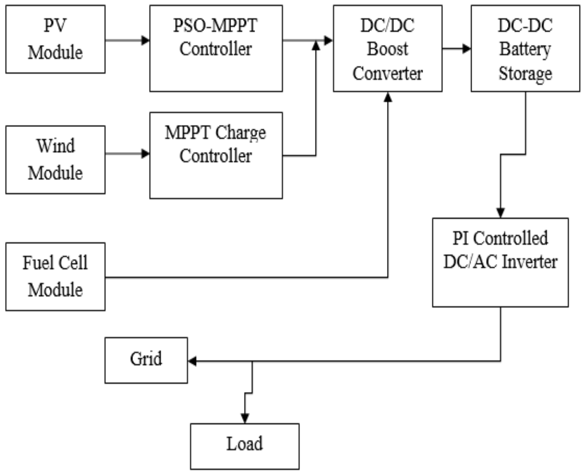

Figure 2: Block diagram of Scenario II (Hybrid RE System with PI Controlled Inverter)

C. *Case 3: PSO-MPPT with Backstepping and Fuzzy Inverter Controller for Hybrid Grid System*

In this research, a grid-connected hybrid renewable energy system is simulated and analyzed. The general block diagram of the system under consideration is shown in Fig. 3.4. The system consists of solar panel, wind system and fuel cell system with particle swarm optimization with maximum power point tracking with charge reverse controller, battery packs, AC / DC converter (output voltage can be modified) and fuzzy logic controller to improve performance. In this system the load was powered with direct current and not alternating current. B. Grid synchronization, which requires information on the phase angle of the grid voltage to transmit the power of the converters. To avoid complications, a simple but effective system has been proposed.

The inverter with RES interface functions here as an active shunt filter. The intermediate circuit voltage must be kept constant for the active branch filter to function satisfactorily, the intermediate circuit voltage is recorded and compared to the reference value and the error is then handled with the fuzzy command.

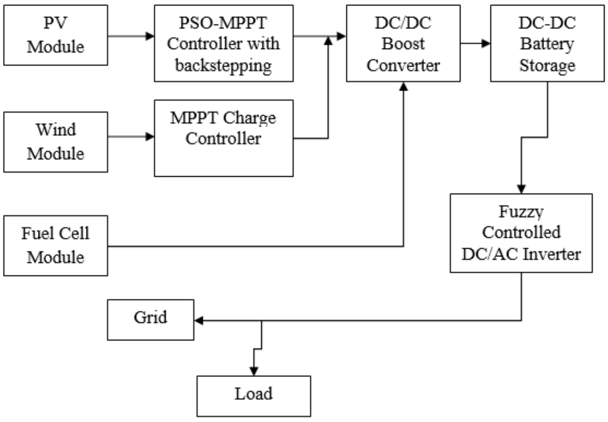

Figure 3: Block diagram of Scenario II (Hybrid RE System with Fuzzy Controlled Inverter)

In this research, the photovoltaic system realized consists of a single conversion stage in which the photovoltaic generator is connected directly to the inverter connected to the grid. The algorithm used to execute MPPT is based on the PSO method. In other words, the proposed PSO-MPPT technique is used to trace the global maximum power point (GMPP) of the photovoltaic array as they improve the overall performance of the photovoltaic system.

D. *PSO MPPT Technique with Backstepping Control*

Particle swarm optimization PSO is a novel swarm optimization algorithm that is firstly proposed by Kennedy as an evolutionary algorithm based on behavior of birds. PSO uses a set of particles that each one suggests a solution to the optimization problem [13]. It is based on the success of all particles that emulates a population where the position of each particle depends to the agent position to detect the best solution P_{best} by using current particles in the population G. The position of any particle xi is adjusted by

$$x_i^{k=1} = x_i^k + v_i \tag{3.4}$$

where the velocity component vi represents the step size and is calculated by:

$$v_i^k = w v_i^k + c_1 r_1 \left(P_{best_i} - x_i^k\right) + c_2 r_2 (G - x_i^k) \tag{3.5}$$

where x is the inertial weight, c_1 and c_2 are the acceleration coefficients, r_1 and r_2 are random values that belong to the interval of [0, 1], P_{best_i} is the best position of particle i, and G is the best position in the entire population.

A typical MPPT method should be used to integrate PSO algorithm to controller.

The flow diagram of an MPPT based on PSO algorithm is shown in Figure 3.4. The operation shown in the flowchart can be analyzed in five steps: initialization, fitness evaluation, updating of the best individual and overall value, updating of the speed and position of each particle and determination of convergence. In the first phase, the particles are randomly initialized in the distribution space or initialized on the described grid nodes that cover the search space [14].

Likewise, the initial velocity values are randomly defined. The fitness value of each particle is evaluated in the second step in which the suitability assessment is performed to provide a candidate solution for the objective function. The best individual and general fitness values are determined in the third phase

where pbest_i and gbest are determined. Thus, the positions will be updated and replaced with the best fitness values if they are found. The speed and position of each particle are updated in the fourth step. The last step in the flowchart examines the convergence criterion. If the criterion is satisfied, the process is complete. Otherwise, the iteration number is incremented and the procedure returns to step 2.

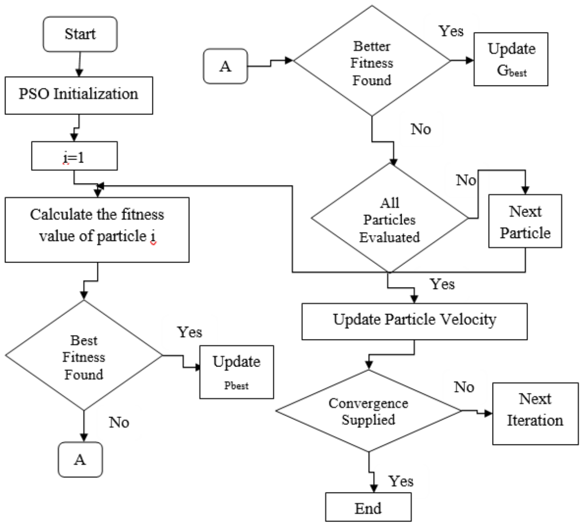

Figure 4: PSO-MPPT Technique

The application of PSO MPPT in a photovoltaic system depends on the coherent definitions of the two systems. The positions of the particles are used to define the working cycle of the DC converter and the function of evaluating the physical fitness value represents the output power of the PV generator. The algorithm's success is achieved by increasing the number of particles that provides a more accurate MPP tracking operation, even for shading problems. On the other hand, a larger number of particles lead to greater complexity. The range of particles is generally chosen because the number of cells connected in series in a PV array is such as to obtain the most precise operating time.

The algorithm updates the swarm as following :

```
For each particle
    Initialize particle
Do
    For each particle
        Calculate fitness value
        If the fitness value is better than the best fitness value ($p_{best}$) in history set current value as the new $p_{best}$
    End
    Choose the particle with the best fitness value of all the particles as the $g_{best}$
    For each particle
        Calculate particle velocity
        Update particle position
    End
While maximum iterations or minimum error criteria is not attained.
```

Calculation of fitness function:

Each Particle's fitness function is calculated using p_{best}as well as g_{best} which is best position among entire group of particles.

In each generation velocity and position of each particle is updated using following equation

$$v = w*v + c_1 * r_1 * (p_{best} - present\_position) + c_2 * r_2 * (g_{best} - present\_position)$$

$$present\_position = present\_position + v$$

Where, v is the particle velocity

present_position is the current particle (solution)

p_{best} and g_{best} are defined as stated before.

r_1 and r_2 is a random number between (0,1).

c_1, c_2 are learning factors which is calculated using acceleration coefficients (ϕ_1 and ϕ_2).

C_1=1+rand();

C_2=ϕ-rand();

Where $\phi = \phi_1 + \phi_2$

w=inertia weight which is calculated as:

w= K_i*rand()

where K_i=1/N, N is number of particles

rand() is a random parameter uniformly distributed in [0,1].

In the proposed strategy every particle uses a different inertia weight to provide exploitation capability to the particles. The two learning factors, C_1 and C_2 are other two important parameters deciding the performances of a PSO.

Further, a back-stepping module to track the PV reference voltage generated by the PSO-MPPT block. This controller can generate a suitable duty cycle for controlling a power transistor of the boost converter using a PWM generator.

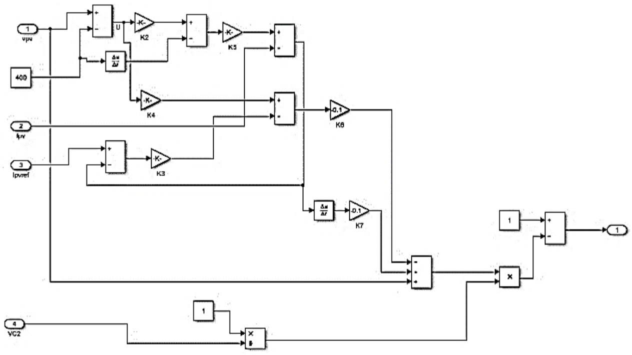

Figure 5: Back Stepping Control of PSO-MPPT

E. Fuzzy Logic Control for Inverter

The function of DC link controller is to track the voltage across the capacitor, compare it with the reference value, and process the error value in such a way that steady state error is zero. A PI controller is used conventionally to set the error value zero. Traditional controller is replaced by a fuzzy controller. Input variables for the fuzzy controller are the error signal and the change of this error.The following seven fuzzy levels are chosen for each input and output variables as NH (-ve high), NM (-ve medium), NL (-ve low), Z (zero), PL (+ve low), PM (+ve medium), and PH (+ve high).Table 1 shows the rules formed on the basis of the fact that control output should be high and low error. Figure 6-8 shows the input variables and output variable membership functions.

Table 1: Fuzzy Rule Table for Inverter

error/coe	NM	NS	Z	PS	PM	NL	PL
NM	NH	NH	NM	NL	Z	NH	PL
NS	NH	NM	NL	Z	PL	NH	PM
Z	NM	NL	Z	PL	PM	NH	PH
PS	NL	Z	PL	PM	PH	NM	PH
PM	Z	PL	PM	PH	PH	NL	PH
NL	NH	NH	NH	NM	NL	NH	Z
PL	PL	PM	PH	PH	PH	Z	PH

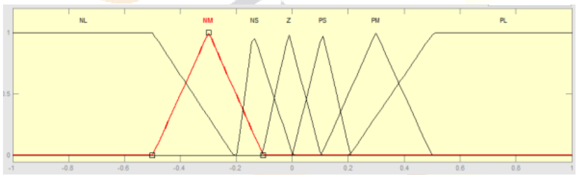

Figure 6: Input Variable (Error) Normalized Membership Function

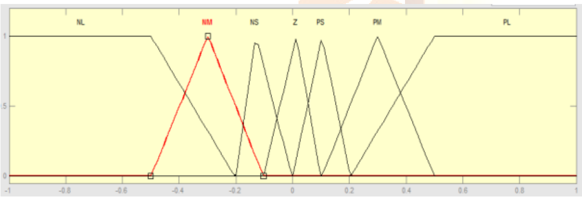

Figure 7: Input Variable (COE) Normalized Membership Function

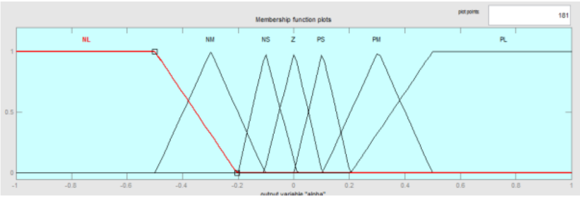

Figure 8: Output Variable Normalized Membership Function

Simulation is carried out for a fixed RES generation, which is greater than the load demand. The result of both scenarios is compared.

IV. RESULT ANALYSIS

A. Case 1 : MPPT with Backstepping and Fuzzy Inverter Control

In this proposed model, a control strategy is presented for hybrid power grid system is presented for maximum application of renewable resources. As wind and solar energy are freely available so, it is most attracting research area to utilize much of these renewable resources for power generation as they are eco-friendly. For extracting much of power resources, MPPT algorithm is used by application of fuzzy control system. In this system, two power sources are used such as solar and wind in order to supply power simultaneously. In this scenario, the MPPT is implemented without using PSO algorithm. In this scenario backstepping is applied with fuzzy inverter control strategy.

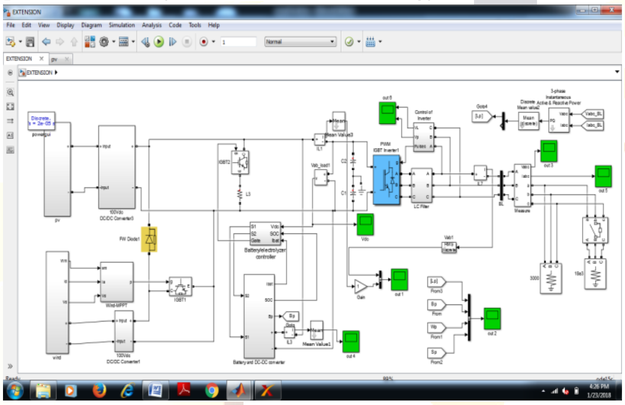

Figure 9: MATLAB Simulink Model of Solar-Wind RE System with PI Controlled Inverter

The inverter converts the DC output from non-conventional energy into useful AC power for the connected load. This hybrid system operates under normal conditions which include normal room temperature in the case of solar energy and normal wind speed at plain area in the case of wind energy. The simulation results are presented to illustrate the operating principle, feasibility and reliability of this proposed system.

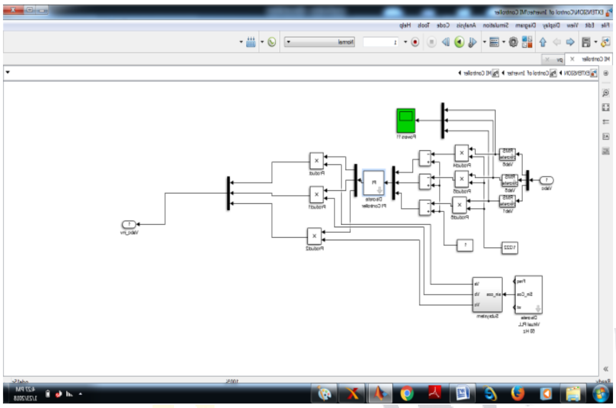

Figure 10: MATLAB Simulink Model of Controlled Inverter for Solar-Wind RE System

The system parameters used in scenario are as shown in Table 2.

Table 2: Scenario I System Parameters

S. No.	System Parameters	Values
1	Hybrid System	Solar & Wind System
2	Solar Panels	11*2=666 V
3	Wind Speed	12 m/s
4	Storage Battery	200 volts, 6.5 Ah Ni-MH battery
5	LC Filter	L = 50 milli henry, C = 2000µfarad
6	3 Phase RLC Load	3KW
7	Proportional Gain (K_p)	0.5
8	Integral Gain (K_i)	7.5
9	Inverter	Carrier frequency= 2000 Hz sampling time= 20 µsecs
10	Switching Device	IGBT

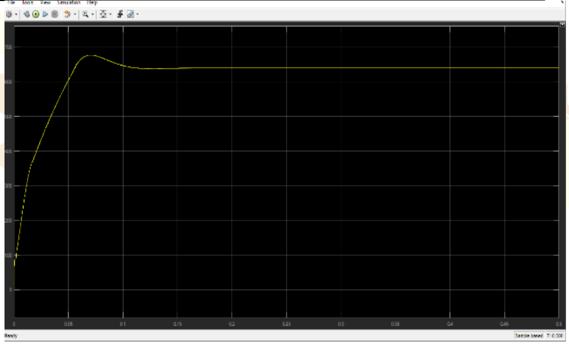

Figure 11: DC Voltage obtained in Solar-Wind RE System

Figure 11 shows the DC voltage obtained from Solar-Wind renewable energy source grid system.

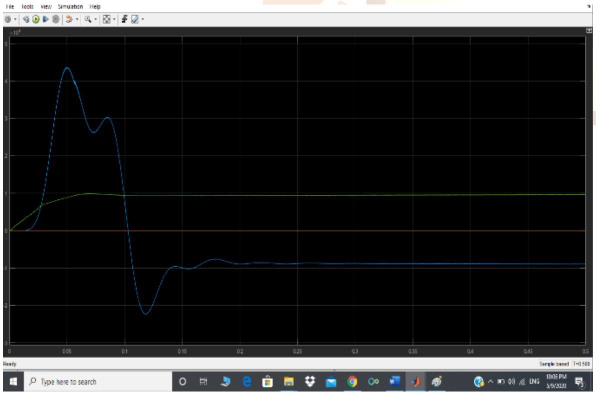

Figure 12: Power Obtained in Solar-Wind System RE System

Figure 12 shows the Power obtained from Solar-Wind renewable energy source grid system.

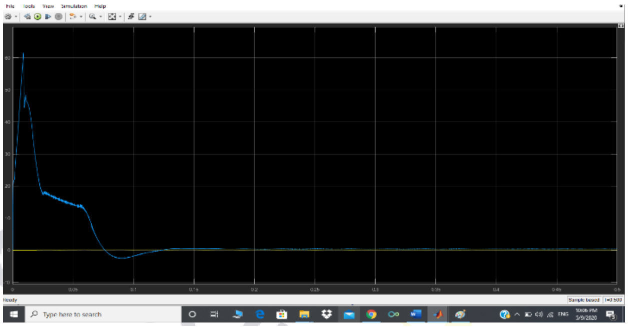

Figure 13: Current Obtained in Solar-Wind System RE System

Figure 13 shows the Current obtained from Solar-Wind renewable energy source grid system.

B. *Case 2: PSO-MPPT and PI Inverter Control*

The system consists of a solar panel, wind system and fuel cell system with particle swarm optimization maximum power point tracking without backstepping controller, battery packs, AC/DC converter (output voltage can be varied) and PI controller integrated inverter control for power improvement. In this system, the load has been supplied by DC, not AC. Such as, grid synchronization, where Information about phase angle of the grid voltage is required to transfer the power from converters. To avoid the complications, a simple yet efficient system has been proposed.

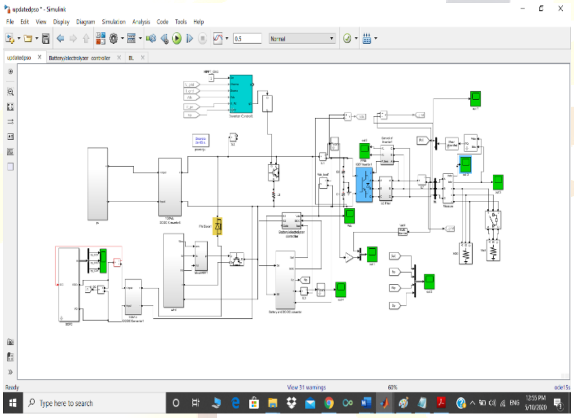

Figure 14: MATLAB Simulink Model of Hybrid RE System with PSO-MPPT and PI Controlled Inverter

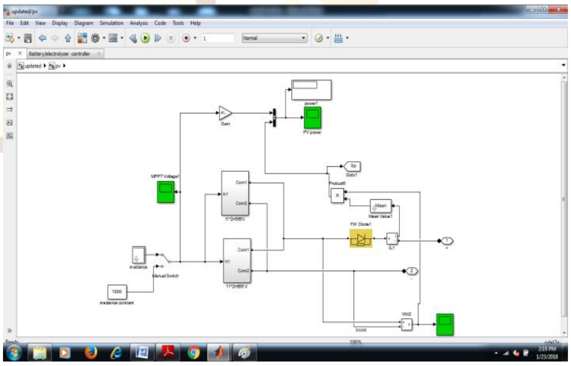

Figure 15: MATLAB Simulink Model of Solar RE System with PSO-MPPT Controller

The charge controller actually is a DC/DC converter that tracks the maximum power from the solar panel. As the maximum power varies with the change of the weather condition, a maximum power point tracking algorithm (particle swarm optimization) is implemented in the charge controller.

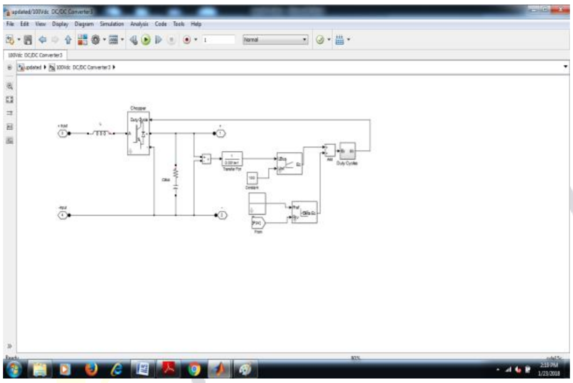

Figure 16: MATLAB Simulink Model of Solar RE DC-DC Converter

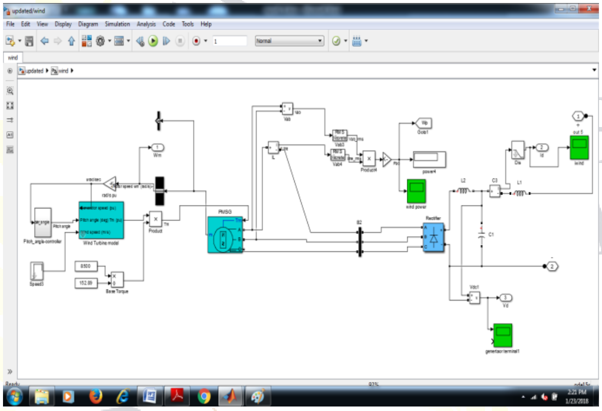

Figure 17: MATLAB Simulink Model of Wind RE System with MPPT Controller

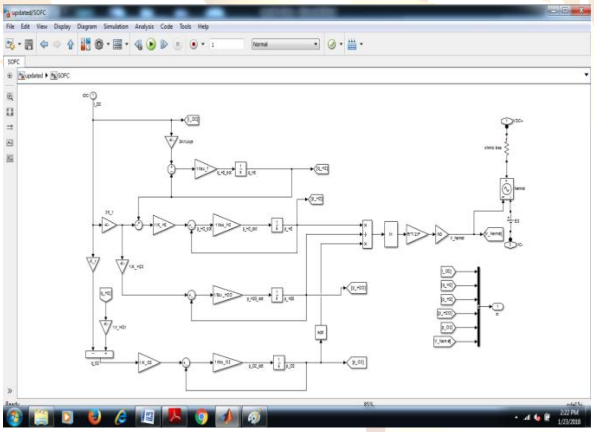

Figure 18: MATLAB Simulink Model of Solid Oxide Fuel Cell RE System

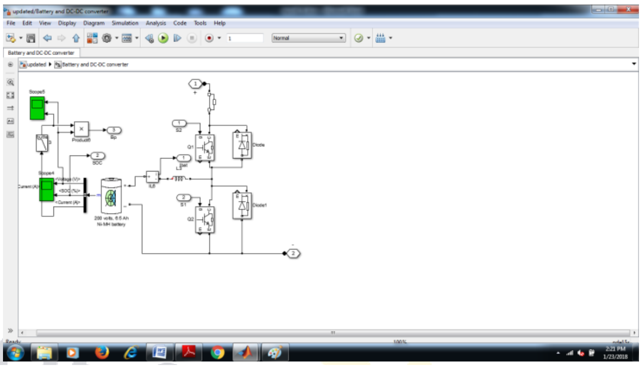

Figure 19: MATLAB Simulink Model of Wind DC-DC converter with Battery Storage

The inverter converts the DC output from non-conventional energy into useful AC power for the connected load. This hybrid system operates under normal conditions which include normal room temperature in the case of solar energy and normal wind speed at plain area in the case of wind energy. The system parameters used in scenario are as shown in Table 3.

Table 3: Scenario II System Parameters

S. No.	System Parameters	Values
1	Hybrid System	Solar, Wind System & Fuel Cell
2	Solar Panels	11*2=666 V
3	Wind Speed	12 m/s
4	Storage Battery	200 volts, 6.5 Ah Ni-MH battery
5	LC Filter	L = 50 milli henry, C = 2000µfarad
6	3 Phase RLC Load	3KW
7	Proportional Gain (K_p)	PI Controlled
8	Integral Gain (K_i)	
9	Inverter	Carrier frequency= 2000 Hz, sampling time= 20 µsecs
10	Switching Device	IGBT

The simulation results are presented to illustrate the operating principle, feasibility and reliability of this proposed system are shown in figure 20-22.

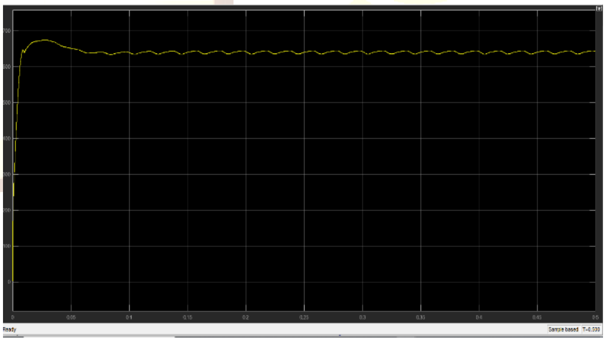

Figure 20: DC Voltage obtained in Hybrid RE System with PSO-MPPT and PI Controlled Inverter

Figure 20 shows the voltage obtained from fuzzy controlled inverter for hybrid renewable energy source grid system.

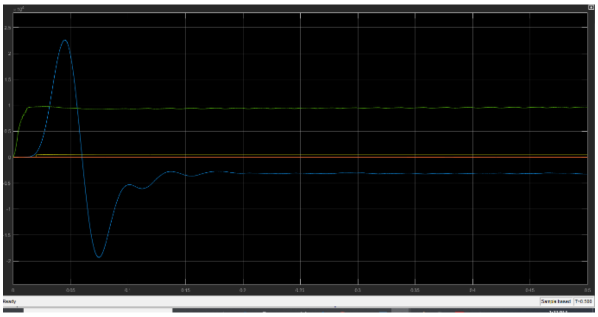

Figure 21: Power Obtained in Hybrid RE System with PSO-MPPT and PI Controlled Inverter

Figure 21 shows the power obtained from fuzzy controlled inverter for hybrid renewable energy source grid system.

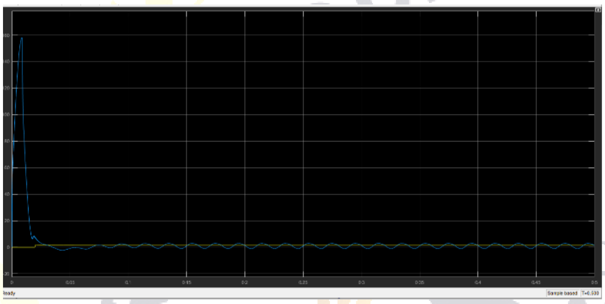

Figure 22: Current Obtained in Hybrid RE System with PSO-MPPT and PI Controlled Inverter

Figure 22 shows the current obtained from fuzzy controlled inverter for hybrid renewable energy source grid system.

C. PSO-MPPT with Backstepping and Fuzzy Inverter Control

The system consists of a solar panel, wind system and fuel cell system with particle swarm optimization maximum power point tracking with backstepping controller, battery packs, AC/DC converter (output voltage can be varied) and fuzzy controller integrated inverter control for power improvement. In this system, the load has been supplied by DC, not AC. Such as, grid synchronization, where Information about phase angle of the grid voltage is required to transfer the power from converters. To avoid the complications, a simple yet efficient system has been proposed.

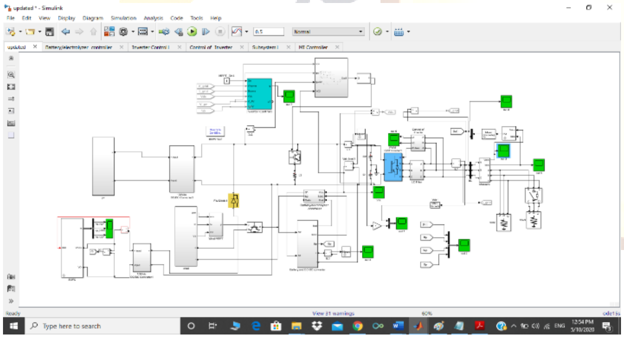

Figure 23: MATLAB Simulink Model of Hybrid RE System with PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter

A fuzzy controlled inverter is used for interfacing the renewable energy system with the grid. Here, inverter not only acts as an interfacing system for real power flow to the grid, but acts as a power quality improving device also. Control methods used for the system plays an important role in the performance of the inverter. Conventional controllers are replaced by fuzzy controllers at this stage.

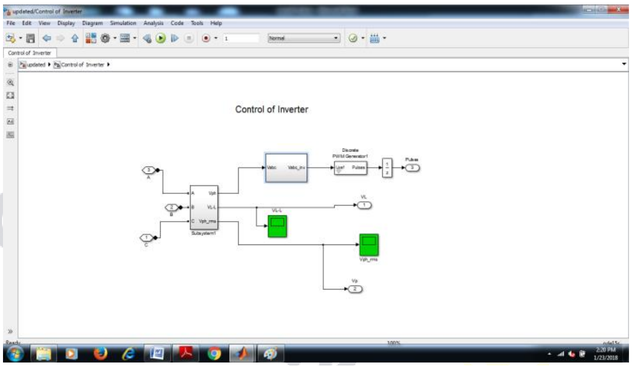

Figure 24: MATLAB Simulink Model of Fuzzy Controlled Inverter

The inverter converts the DC output from non-conventional energy into useful AC power for the connected load. This hybrid system operates under normal conditions which include normal room temperature in the case of solar energy and normal wind speed at plain area in the case of wind energy. The system parameters used in scenario are as shown in Table 4.

Table 4: Scenario III System Parameters

S. No.	System Parameters	Values
1	Hybrid System	Solar, Wind System & Fuel Cell
2	Solar Panels	11*2=666 V
3	Wind Speed	12 m/s
4	Storage Battery	200 volts, 6.5 Ah Ni-MH battery
5	LC Filter	L = 50 milli henry, C = 2000µfarad
6	3 Phase RLC Load	3KW
7	Proportional Gain (K_p)	Fuzzy Controlled
8	Integral Gain (K_i)	
9	Inverter	Carrier frequency= 2000 Hz, sampling time= 20 µsecs
10	Switching Device	IGBT

The simulation results are presented to illustrate the operating principle, feasibility and reliability of this proposed system are shown in figure 25-27.

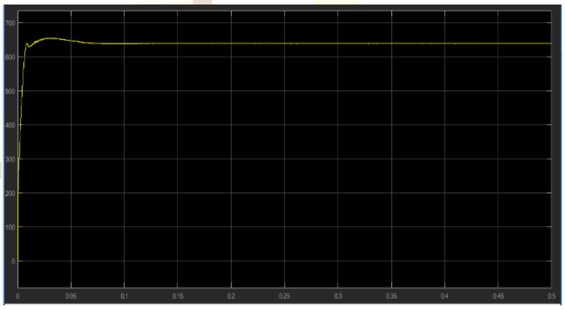

Figure 25: DC Voltage obtained in Hybrid RE System with PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter

Figure 25 shows the voltage obtained from PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter for hybrid renewable energy source grid system.

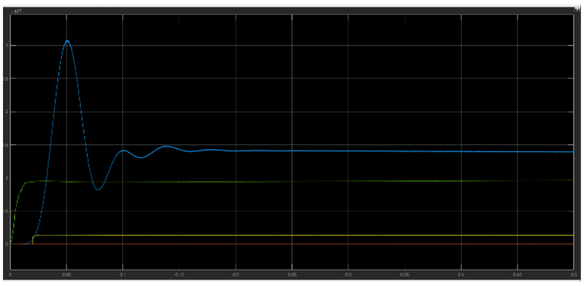

Figure 26: Power Obtained in Hybrid RE System with PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter

Figure 26 shows the power obtained from PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter for hybrid renewable energy source grid system.

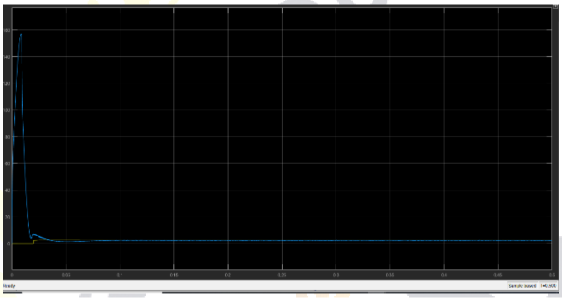

Figure 27: Current Obtained in Hybrid RE System with PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter

Figure 27 shows the current obtained from PSO-MPPT Integrated with Back Stepping Control and Fuzzy Controlled Inverter for hybrid renewable energy source grid system.

D. Comparison of Scenario I, Scenario II and Scenario III

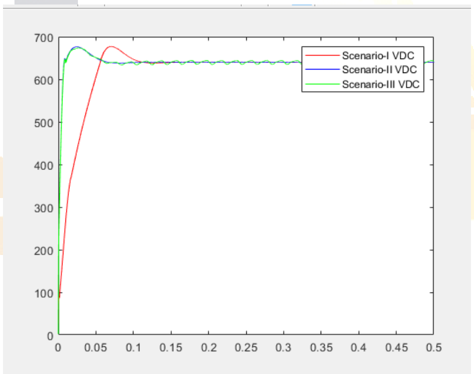

Figure 28: DC Voltage Comparison of Scenario I, Scenario II and Scenario III

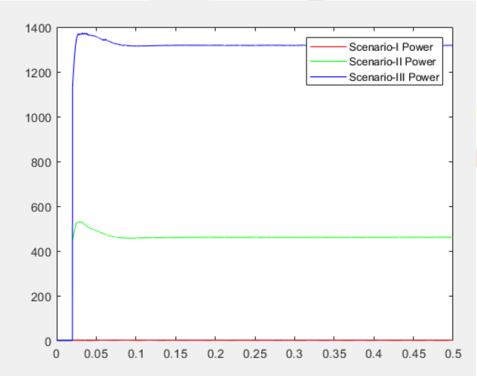

Figure 29: Power Comparison of Scenario I, Scenario

V. CONCLUSION

In this work, performance of hybrid grid system with PSO-MPPT MPPT technique with and without backstepping is used to extract the maximum power from hybrid system. The paper investigates the performance of MPPT with and without optimization, while simulation results considering the maximum power extracted from a PV array have also been obtained. Along with optimized MPPT control unit, the system is also modeled with fuzzy controlled inverter to reduce or remove the drawbacks of the earlier conventional inverters. PSO-MPPT with backstepping control is done for PV and wind energy so that maximum power is tracked and system work more reliably and efficiently. MATLAB/ SIMULINK software is used to model the architecture of proposed model and from simulation result it is found that the efficiency of grid DC Voltage has been improved.

VI. FUTURE SCOPE

In future work the work will be focused to improve the obtained power quality for three phase grid system with dynamic load condition. There would be also implemented the fault tolerance control logic unit which can provide transient stability to the entire system in a very effective manner**.**

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