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Modified Hybrid MPPT for Hybrid Renewable Energy Conversion System

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***Abstract*— The main theme of this paper is to propose a hybrid MPPT algorithm for the Hybrid system comprising of Wind and Solar Energy system. In the hybrid MPPT we combined the features of P & O and Hill climbing algorithm for the fast and better tracking efficiency. Here the hybrid MPPT technique is used to design the MPPT and to generate the control signals for the converters. The converter used is proposed to be of boost type that is used to step up the source voltage to the suitable value of the grid. The simulation can be implemented for this project using MATLAB. With the implementation of this project grid stability, efficiency and speed of the tracking system can be analyzed. The proposed control framework has been actualized in MATLAB programming and tried for different wind and load conditions.**

Index Terms— Battery storage, Hybrid Excellence Controller (HEC), Energy Management And Power Regulation System, PV cell, load control, hybrid power system, wind energy conversion system.

I. INTRODUCTION

Renewable energy is the energy which comes from natural resources such as sunlight, wind, rain, tides and geothermal heat. These resources are renewable and can be naturally replenished. Therefore, for all practical purposes, these resources can be considered to be inexhaustible, unlike dwindling conventional fossil fuels [1]. The global energy crunch has provided a renewed impetus to the growth and development of Clean and Renewable Energy sources. Clean Development Mechanisms (CDMs) [2] are being adopted by organizations all across the globe. Hybrid power generation systems provide an environmentally friendly alternative to grid connected and standalone operations. However, there are several challenges to the hybrid power system. Appropriate control and coordination strategies among various elements of the hybrid system are required so it can deliver required power. Renewable-energy-based hybrid systems must also be also reliable and cost-effective. A renewable energy system converts the electric power found in sunlight, wind, falling water, tidal, heat energy or biomass into a form; we can use such as heat or electricity. This paper proposes about improve regulation and performance of hybrid stand-alone energy system.

II. PREVIOUS RESEARCH:

Numerous related research works have already existed in literature which based on Hybrid MPPT control, THD and Voltage compensation system. Some of them are reviewed here.

Luigi Galotto *et al* [7]. Presented the evaluations among the most usual maximum power point tracking (MPPT) techniques, doing meaningful comparisons with respect to the amount of energy extracted from the photovoltaic (PV) panel tracking factor in relation to the power, PV voltage ripple, dynamic response, and use of sensors. Using MatLab / Simulink and dSPACE platforms, a digitally controlled boost dc–dc converter was implemented and connected to an Solar Array simulator in order to verify the analytical procedures.
M. Imran Hamid *et al* [9].presented the modeling and simulation of wind energy and solar hybrid generation system for grid connected system. The proposed system consists of buck converter, pulse width modulation inverter, synchronizing system. The synchronizing system operation is to verify whether the output of the PWM inverter is same as the grid system. The synchronizing system consists of voltage, frequency and phase comparator. Modeling and simulation of the entire system is carried out using PSPICE.

Sweeka Meshram *et al*[10],presented simulation modeling of the grid connected DC linked PV/Hydro hybrid system has been done. The DC bus of the PV and hydro system has been common linked to reduce the cost and complexity of the hybrid system. The hybrid system acts as a dominant system and power grid will be acts as a standby to compensate the deficit in the hybrid system. In rainy days/night, the solar energy will be unavailable, hence the power requirement will fulfilled by hydro system and power grid. In summer, the hydro power will be less; in that case the power requirement will be fulfilled by the PV system and power grid. In other days, the power will be fed by the PV/Hydro hybrid system. Thus, the power requirement throughout the year can be satisfied by the proposed system. The proposed system is

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tested under the linear resistive, RL and Induction Motor (IM) as a dynamic load.

Yuan-Chih Chang *et al* [8]. This paper develops the operational control of two maximum power point trackers (MPPTs) for two-string photovoltaic (PV) panels in dc distribution systems. This dc distribution system is connected to ac grid via a bidirectional inverter. Two PV strings and two MPPTs are implemented in this system. The proposed MPPT topology consists of buck and boost converters to deal with wide output voltage range of PV panels. To accurately determine the input current of MPPTs, the PV-string configuration check is accomplished online. The perturbation and observation method are applied for maximum power point tracking. Moreover, the current balancing of two MPPT modules in parallel is achieved. In this paper, the system configuration and the operational principle of the proposed MPPT are first introduced.

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E. M. Natsheh, *et al*[11], Implemented the model of smart grid-connected PV/Wind hybrid system was developed. It comprises photovoltaic array, wind turbine, asynchronous (induction) generator, controller and converters. The model was implemented using MATLAB/SIMULINK software package. Perturb and observe (P&O) algorithm was used for maximizing the generated power based on maximum power point tracker (MPPT) implementation.

Yipeng & Heng (2015) presented a modularized control strategy for wind energy conversion system. Two converters such as grid side and rotor side converters are considered and both the converters are operated to reach MPP.

All the above said methods have certain difficulties in obtaining the maximum power point. Hence three MPPT methods are proposed to receive maximum power from solar and wind energy conversion system.

III. PROPOSEDMETHODOLOGY:

The advanced hill climbing based algorithm consists of hybrid algorithm using a different algorithm technique along with the hill climbing method for faster and accurate tracking of MPP. The voltage and current controlled algorithms are more accurate and effective than most commonly used hill-climbing algorithms at low solar radiation. Therefore these algorithms are combined with P&O and INC algorithms to increase their effectiveness. The hill climbing based algorithms oscillate around the MPP in slow varying atmospheric conditions.

Therefore to decrease losses due to oscillations, the hill climbing based algorithms are suitable in only rapidly changing atmospheric conditions and the constant voltage method is fast and sufficient for constant conditions. The two mode control algorithm combines these two algorithms by using incremental conductance method for more than 30% normalized solar radiation and constant voltage method for less than 30% normalized radiation.

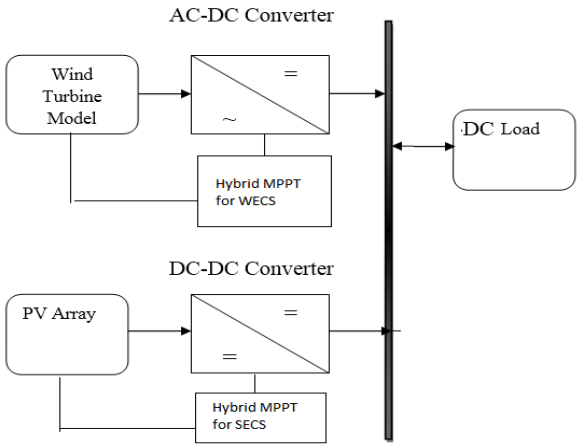

Fig. 1 **Block diagram of Proposed Hybrid MPPT for HECS**

Modelling of Photovoltaic Array

In PV framework daylight vitality is changed over into power in view of the idea of photovoltaic impact. The photo current relies on upon light and temperature. On the chance that irradiation is higher current discharged by the cell will be more. A perfect solar cell is spoken to by a Current source and a diode parallel with it. However no solar cell is perfect there by series resistance Rs which has little esteem and Rsh is the comparable shunt resistance whose esteem is high. The PV cell current Equation (1) as takes after

$$I = I_{PV,Cell} - \left(I_0\left(V + \frac{IR_S}{V_T}\right) - 1\right) + \left(V + \frac{IR_S}{R_P}\right) \quad (1)$$

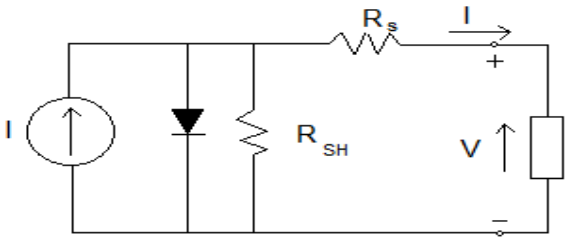

Fig. 2 **Modelling of Photovoltaic Array**

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Where Ipv, cell is the current created by the incident light, rely on upon the solar powered radiation and cell temperature. Io is the reverse saturation or leakage current of the diode, VT is the thermal voltage.

Wind Energy Conversion (WEC) system

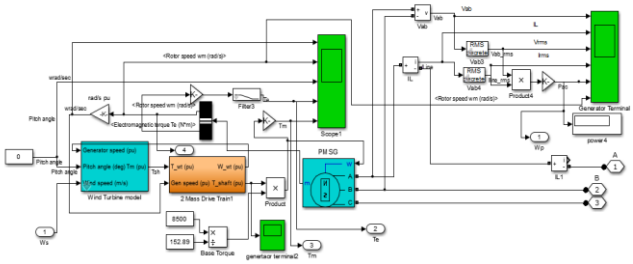

Fig. 3 **Wind- Machine Simulation model**

Building blocks of WECS are wind turbine, doubly fed induction generator (DFIG), and two masse drive train Pitch point controller and consecutive converters. Wind power is a standout amongst the most imperative sources of renewable energy. For a wind turbine, if the wind speed surpasses the cut-in esteem, the wind turbine generator begins producing energy.

IV. HYBRID MPPT METHODOLOGY

In Hybrid framework number of electrical power generators and electrical power storage components are joined together to take care of the electrical power demand of remote and in addition provincial territory or even an entire group. It is additionally utilized as a standalone control framework, is a self-sufficient framework that provisions power to the client Load without being associated with the electrical power grid. In this model Solar PV and WECS is joined to get hybrid framework which is conveying energy to load combinable.

This algorithm has four cases as given below.

Case 1: If Power P(n) > P(n-1), then update voltage V(n-1) and current I(n-1)

Case 2: If Power P(n) < P(n-1) & dV = dI =0, then update voltage V(n-1) and current I(n-1).

If Power P(n) < P(n-1) & dV≠0 & dI/dV= -I/V, then update voltage V(n-1) and current I(n-1).

Case 3: If Power P(n) < P(n-1) & dV≠0, then

If dI/dV > - I/V then duty cycle D=D+ΔD and update voltage V(n-1) and current I(n-1).

If dI/dV < - I/V then duty cycle D=D-ΔD and update voltage V(n-1) and current I(n-1).

Case 4: If Power P(n) < P(n-1) & dV=0 & dI ≠0, then

If dI > 0, duty cycle D=D-ΔD and update voltage V(n-1) and current I(n-1).

If dI < 0, duty cycle D=D+ΔD and update voltage V(n-1) and current I(n-1).

In this hybrid MPPT algorithm for solar power system, from the measurement of solar panel output voltage and current the solar power is calculated. The duty cycle is adjusted by a small amount ΔD to reach the maximum power point based on the change of solar power, voltage and current. This algorithm is very effective, since it considers all the three parameters of solar power system.

V. RESULTS AND DISCUSSION:

The Hybrid MPPT algorithm for Hybrid power system is implemented in MATLAB as a sub-system. Solar panel is simulated in MATLAB. Temperature and irradiance are taken as input to the solar panel. The solar panel develops voltage across its output terminals according to the temperature and irradiance. The solar panel is connected to the boost converter. The converter matches the impedance of the solar panel to the impedance of the load to enable to transfer the maximum power from solar PV system to the load. The boost converter feeds the load. When the load changes, the solar panel acts as a source supplying the power. MPPT for the solar panel is achieved by hybrid the incremental conductance and hill climbing methods.

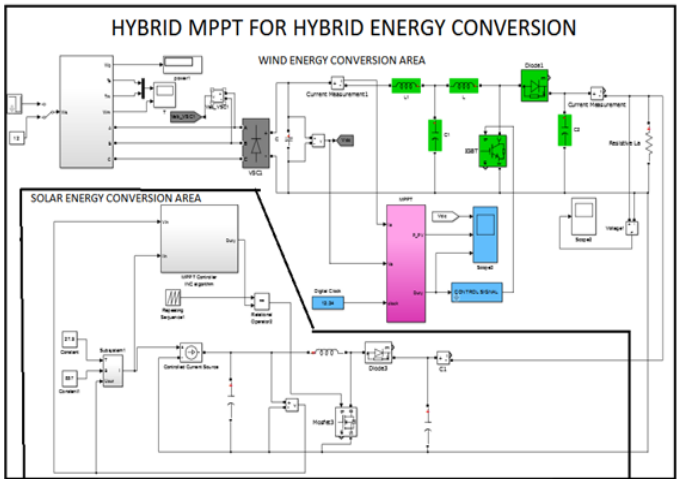

Fig. 4 **Simulation design of Hybrid MPPT for HECS**

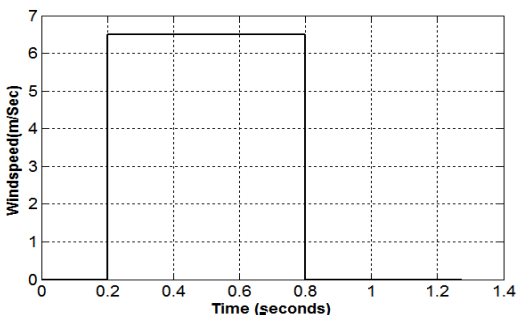

Fig. 5 **Wind speed**

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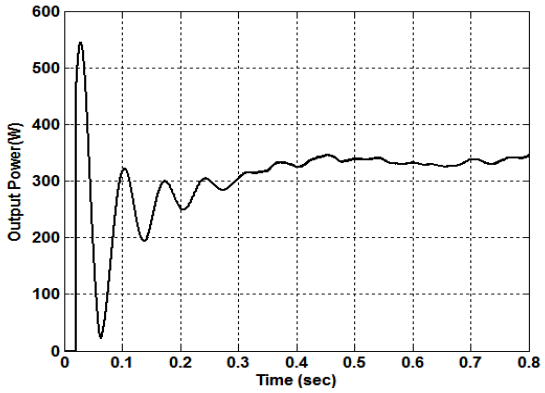


Fig. 6 **Power output**

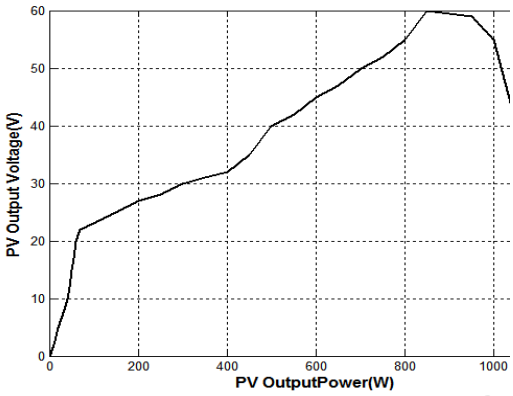


Fig. 7 **Voltage versus Power for the solar irradiance (1000 w/m^2) in hybrid MPPT technique**

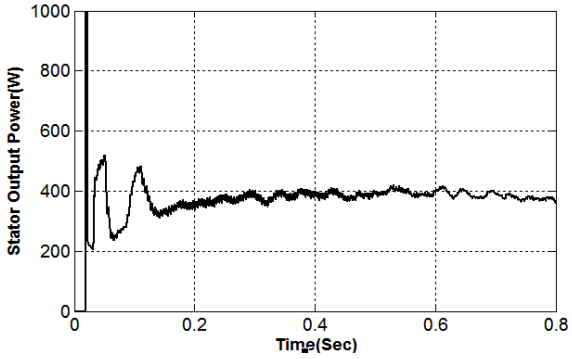


Fig. 8 **Stator Power for the wind speed of 6.5 m/s**

Fig .6 shows the power output of the hybrid system according to the irradiance values from the sun and wind velocity. Fig. 7 shows Voltage versus Power for the solar irradiance (1000 w/m^2) in hybrid MPPT technique.

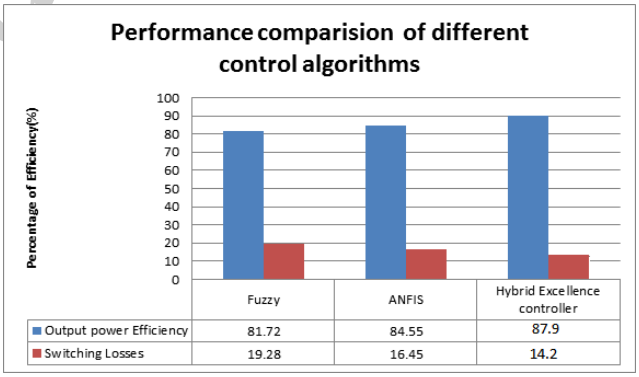
Performance Comparison

From the investigation of reproduction results in the different parameters, for example, switching losses, maximum Output power and efficiency estimations of converters are recorded in Table 2. Fuzzy, ANFIS and Proposed HEC converter has the Efficiency values of 81.72%, 84.55% and 89.92% respectively. The Comparison table clearly shows the effectiveness of the proposed under a different level of control index.

Table I **Comparison of the proposed Model**

Hybrid Sources	Controller used	Output power in per unit	Switching Losses (%)	Maximum output Power Efficiency(%)
PV+Wind	Fuzzy	0.81	19.28	81.72
PV+Wind	ANFIS	0.84	16.45	84.55
PV+Wind	Hybrid MPPT	0.86	14.08	87.92

Maximum power tracking Efficiency comparison of different converters with proposed converter system are shown as graph below



Graph.1 Comparison chart of various controllers based HRES System.

VI. CONCLUSIONS

In this paper has displayed and assessed – Hybrid energy conversion based hybrid MPPT control framework. It comprises of renewable vitality sources Wind Turbine and PV board. The execution of the proposed control procedure is assessed under various wind and load conditions. It is uncovered that the machine side converter can extricate the ideal power. It is likewise ready to work the PM synchronous generator with most extreme proficiency. It builds up the general coordination in energy management conspire. From

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the recreation comes about, the Hybrid MPPT controller oversees and gives the greatest power of the no/low wind condition. The favorable position is to keep away from/keep the framework shut out at the deficient vitality save.

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