International Journal for Research in Engineering Application & Management (IJREAM)
ISSN : 2454-9150 Vol-04, Issue-02, May 2018

Optimal Power Scheduling of Renewable Energy Based System

[1*]Aditya Verma, [2]Prof. Rintu Khanna, [3]Prof. Sandeep Kaur

[1]M.Tech Student, [2]Associate Professor, [3]Assistant Professor, Dept. Of EE, Punjab Engineering College, Chandigarh, India. [1]ares.adi@gmail.com

Abstract--The ultimate objected of this work is to design a scheme to control the power flow a renewable energy system with more than one renewable energy sources (solar energy and wind energy) and energy storage element system like battery. Due to the intermittent nature of the renewable energy sources , the use of energy storage is necessary and also the consequent power shift. The work is based on the hybrid solar photo-voltaic and wind energy device in battery management of standalone applications. Battery charging in this process was non-linear and varies according to time with high time delay so it was difficult to achieve the best energy management performance by using traditional control approaches. In this work, fuzzy approach is used for battery charging or discharging and utilize in renewable power generation system. It was used to manage the state of charge in life cycle of battery. The main aim of this research is to reduce the loss of battery and improve the voltage profile non-linear to linear. All the device designing and modeling is performed on simulate environment of MATLAB/Simulink environment. In this research work which also analysis three different cases that are single source, hybrid source and battery in fix load.

Keywords: Battery, Control, Energy storage, Hybrid, Renewable Energy, Standalone

I. INTRODUCTION

Solar and wind energy systems are omnipresent, freely available, environmental friendly, and they are considered as promising power generating sources due to their availability and topological advantages for local power generations. Hybrid solar–wind energy systems, uses two renewable energy sources, allow improving the system efficiency and power reliability and reduce the energy storage requirements for stand-alone applications. The hybrid solar–wind systems are becoming popular in remote area power generation applications due to advancements in renewable energy technologies and substantial rise in prices of petroleum products. Economic, industrial and social development of any nation requires energy. The significant energy sources are petroleum derivatives, which have been over-used prompting awful impacts, for example, air contamination and annihilation of nature. Consuming of petroleum derivatives discharges destructive gasses, which have extreme results on the living spaces and likewise influence human wellbeing [2].

They are the energy source that is non-renewable as they are gotten from pre-memorable fossils and are not any more accessible once utilized. Their source is constrained and they are being exhausted at a speedier rate.

Renewable energy era is a decent choice to secure nature and in addition an answer towards the constrained accessibility of non-renewable energy source. Distributed generation, likewise approached dispersed generation, site generation, decentralized generation, installed generation, distributed energy or decentralized energy produces electricity from numerous small energy sources. Currently, modern nations produce the greater part of their electricity in substantially together brought offices, for example, hydro-power plants or fossil fuel (coal and gas powered) atomic. These plants have superb scale economies, yet for the most part transmit long electricity separations and influence nature contrarily [3].

Stability is a micro load basic issue in which the electronic source power interfaces are controlled decentralized. Every interface is controlled construct just in light of local measurement, and along these lines, it is essential examining how the individual control systems collaborates for guaranteeing the general stability[4]. In such manner, if an enduring state can come to in which the all voltages principal parts in the micro load have consistent amplitudes and steady relative stage edge contrasts, at that point the framework is steady. In this area, we audit aftereffects of micro load stability examination and likewise show late outcomes in the decentralized controllers with fuzzy logic

II. PROPOSED METHODOLOGY

Displaying of the PV-Wind hybrid system is completed utilizing MATLAB Simulink. The Solar-Wind Hybrid Power System (SWHPS) comprises of a few units, PV power and wind power units as essential energy sources, battery bank unit as helper energy source, dc-air

 DOI : 10.18231/2454-9150.2018.0280

conditioning and dc-dc converters, control and load unit. The capacity of controller unit is to guarantee the power administration, which is conveyed by the hybrid system to fulfill the load request and to charge the battery.

The capacity of dc-dc converter is to change over the unregulated DC voltage to deliver controlled voltage. The inverter unit is utilized to change over the DC produced power from renewable energy sources to nourish the load with the required AC power[5].

The intemperate charge from the battery will be dumped to the dump load unit. The dump load for this situation is the battery stockpiling which would then be able to be utilized to supply power to the load if there should arise an occurrence of deficient power created by essential sources.

Squares, for example, photo-voltaic model, wind demonstrate, dc-wind conditioning converter display ,the energy stockpiling model and dc-dc converter show are incorporated independently before joining with a total hybrid system. The square outline portraying the system theoretical structure is appeared in Figure. The scientific models portraying the dynamic conduct of each of these segments are talked about in next segment[6].

a.) Solar Photovoltaic Subsystem

In this study, it is assumed that maximum power point tracker (MPPT) to extract maximum possible power from PV, and a DC-DC power converter is used to match the MPPT output voltage with the system voltage[7]. The PV cell is operating based on photoelectric effect. It converts light with different wavelengths into current at the PN junction, producing electricity directly from the cell when connected to a load. According to the current produced is given by

$$I_{total} = I_o\left(e^{\frac{qv}{kT}} - 1\right) - I_L$$

where k is Boltzmann's constant, $I_o$sets the current scale and q is the electric charge of the particles which comprise the current Itotal. Also, ILis the light generated current, ant T is the ambient temperature.

Based on the solar irradiance and the ambient temperature, which are two crucial physical quantities in PV technology, the PV cell corresponds to and produce open circuit voltage and closed circuit current .

Thereafter, the PV system is connected to MPPT, DC-DC power converter and finally to the system. For simulation purposes, real solar power data is collected from the University of Queensland which provides live and historical data of installed PV systems[8].

a) *Wind Turbine Subsystem*

A wind turbine converts the kinetic energy of air in terms of air velocity into electric power by using an electrical generator. Wind power is a result of air speed, air density and rotor area [9]. The mechanical power extracted by the rotor, which drives the electrical generator, can be found from

$$P_{eff} = C_P \eta_{gear} \eta_{gen} \eta_{ele} P_w = \frac{1}{2}\left(\eta_t \rho A \overline{\mu^3}\right)$$

where P_{eff} is the percentage of the rated output, P_w is the mechanical power in the moving air ,p is the air density, A is the area swept by the rotor blades, and ų is the velocity of air[10]. This power is applied to the rotor of the electric generator to produce electricity.

WP is only generated after certain cut-in air speed. It then increases with the air speed until reaching a rated steady value, and remains steady until the wind turbine reaches the cut-off speed . The wind turbine is assumed to work in maximum power point. Thereafter, it is connected to MPPT, AC-DC power converter, and finally to the system.

b) *Battery Subsystem*

In this work, batteries are used as the primary energy storage system for short to medium storage term. This subsystem is based on the generic battery block provided by Simscape Power Systems in Simulink environment [11]. The battery type is chosen as a rechargeable Nickel Metal Hydride (Ni-MH) battery. Detail model of the battery system, including the equivalent circuit for both the charging and discharging modes, can be found in [11].

The battery is connected to the system using a bi-directional DC-DC converter with ideal efficiency and behavior, and is controlled by a battery management system that receives control signals from the main controller.

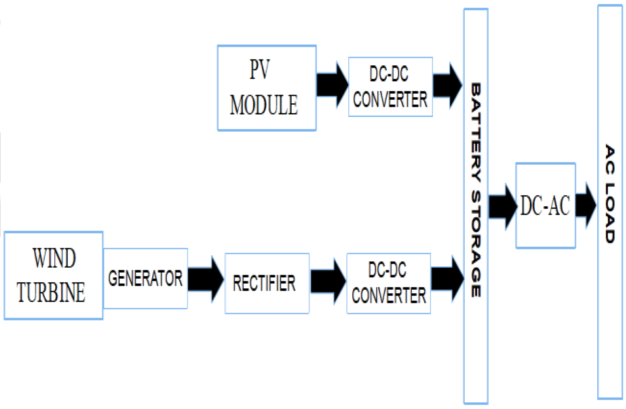

Fig 1.1: Block diagram of system conceptual framework

III. METHODS OF CALCULATING STATE OF CHARGE (SOC)

The calculation of the SOC of a battery may be a problem of more or less sophistication depending on the battery type and on the application in which the battery is used. Since the battery used is Ni-MH , the SOC calculation method describes explicitly for this type of battery system,

 DOI : 10.18231/2454-9150.2018.0280

but apply partially also for the other electrochemical system.

i. Discharge Test

The most effective test for the calculation of SOC of battery i.e its left capacity is a discharge test under uncontrolled conditions. But such a test , which usually includes a consecutive recharge ,is too time consuming to be considered for most applications.

ii. Ampere hour counting

This is the most common technique to calculate the SOC. Since the charge and discharge are directly related to the supplied or withdrawn current, the idea of balancing the battery current is evident. If the starting point SOC is (SOC_i) is given, the value of current integral is the direct indicator for SOC.

$$SOC = SOC_i + \frac{1}{C_N}\int_{t_o}^{t}(I_{bat} - I_{loss})dt$$

Where C_N is the rated capacity, I_{bat} is the battery current, I_{loss} is the current consumed by loss reactions.

Two main complications arise with this method: Firstly, incorrect current measurement could add up to a large error and accurate current measurement is expensive. Secondly, not all current supplied to battery is consumed by charging and the corresponding losses have to be taken into account. The first point can be overcome by investigating money in measuring equipments, while for the second one many different approaches have been developed.

The most simple method for loss estimation is to apply a constant charge factor to the battery at each recharge, i.e. a constant loss is assumed and this loss is additionally returned to the battery. Such a method is only suitable for system that are not too sensitive to overcharge. The Butler-Volmer equation is used to calculate the major losses during charging. Since in PV applications the currents are small, the Butler-Volmer equation becomes

$$I_{loss} = I_O \exp\left(\frac{U_{bat}-U_N}{K_1} - K_2\,\frac{T-T_N}{TT_N}\right),$$

$$I_O = K_O \, exp\left(\frac{U_N}{K_1} - \frac{K_2}{T_N}\right),$$

Where I_{loss} is the current consumed by the loss reactions ; K_0, K_1, K_2 are the constants; U_{batt} and U_N are the battery and the rated battery voltage; T and T_N are the battery temperature and temperature under standard conditions. The errors for this method can be kept low if points for recalibration can be identified. Since in PV applications the time for recharge is limited by the length of daylight, full charge is seldom achieved. Concerning this problem, a so called remaining charge current technique for recalibration is presented which allows recalibrations if the SOC is above 90%. In that field of application, the technique find a limit in the case of high temperature effects and/or high current variations but it can be applied to the all battery system used for EV applications (i.e. lead acid, NiCd, NiMh, lithum systems).

IV. RESULTS

This work is done to achieve the uninterrupted supply for AC loads using fuzzy logic controller and the output waveform are given below, in the output waveform the voltage, current, and power waveforms are displayed and the outputs are analyzed for the comparison voltage stability under different constraints of the hybrid power system. The table below shows that the input parameters for simulation environment.

Wind		**Battery**	
Power	8.5e3 W	Voltage	300V
Speed	12 m/s	Initial SOC	60%
Maximum Power	0.8MW	Maximum Capacity	7KW
Base rotational speed	1	Full charged voltage	353.38V
		Resistance	6.25 Ohm

PV		**Simulation**	
Base Power	100e6	t	300-600V
P_2 Tolerance	1e-4	Minimum voltage	26.3V
Frequency	50 Hz	Nominal voltage	48.0V

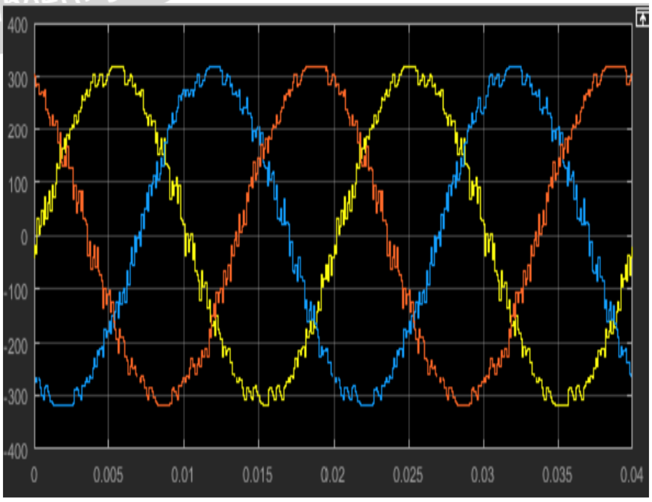

Fig 1.2: Output waveform of load Voltage for AC load

 DOI : 10.18231/2454-9150.2018.0280

The above fig. 1.2 describes the output waveform of the load voltage for AC load in which output load voltage is regulated to provide uniform supply to the utility.

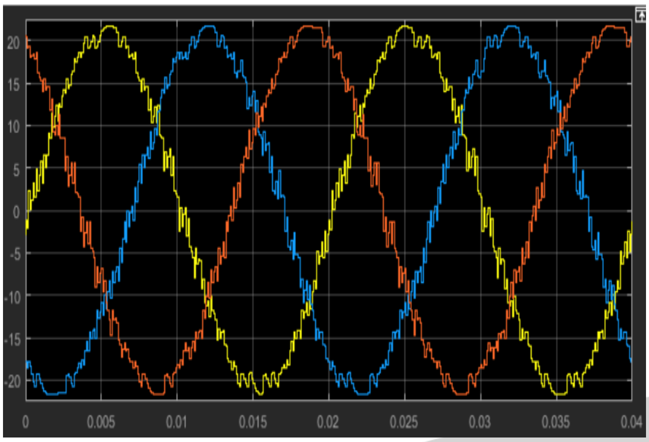

Fig 1.3: Output waveform of load current for AC load

The above fig. 1.3 describes the output waveform of the load current for AC load in which output load current is regulated to provide uniform supply to the utility.

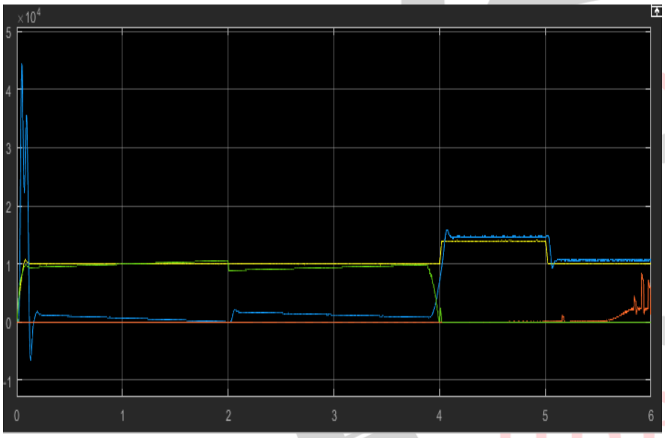

Fig 1.4: Output waveform of PV, wind, battery, load power

The above fig. 1.4 describes the output waveform of the PV power, wind power, battery power and power to the load .

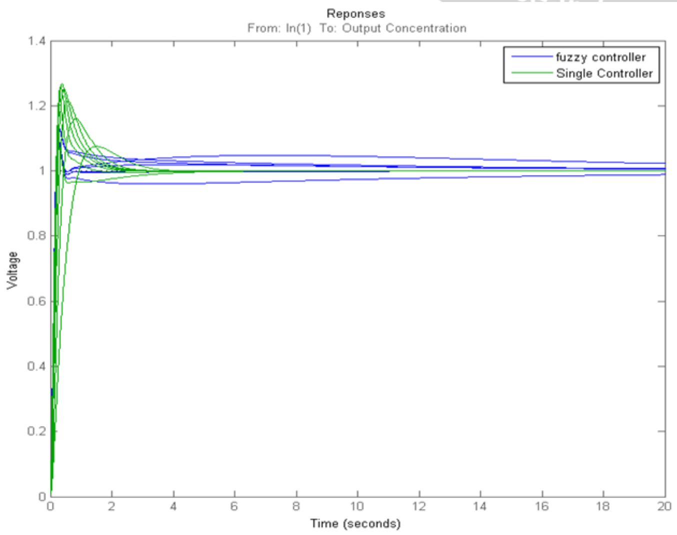

Fig 1.5: Voltage stability comparison

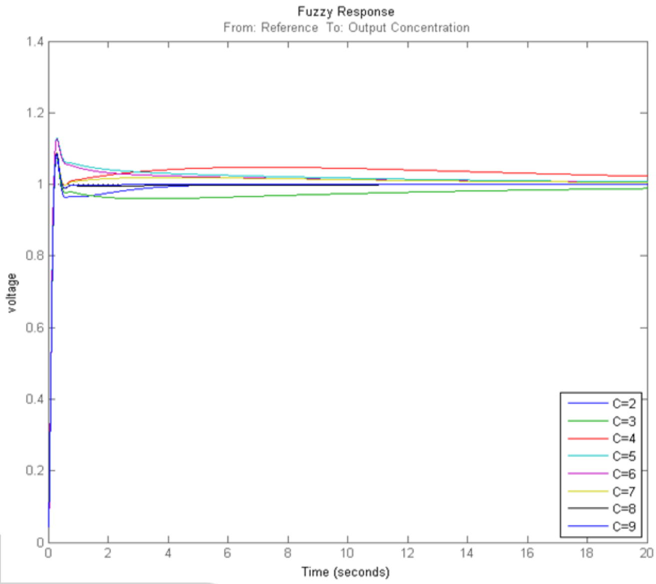

Fig 1.6: Voltage stability comparison in different constraints.

The above fig 1.5 shows that the voltage stability comparison by using single controller and also by using the fuzzy logic controller and in fig 1.6 describes the voltage stability comparison in different constraints.

V. CONCLUSION

The hybrid solar–wind power generation system is recognized as a viable alternative to grid supply or conventional fuel-based remote area power supplies all over the world. It is generally more suitable than systems that only have one energy source for supply of electricity to off-grid applications. However, the design, control, and optimization of the hybrid systems are usually very complex tasks. This paper has reviewed the up-to-date progress of this technology, which includes the feasibility study, component simulations, system optimization and control technologies of the hybrid systems. In this work PV cell module and array are simulated and their effect on the environment is also discussed with the help of graphs.

The Fuzzy logic approach is used for the analysis process in which we calculate the voltage stability and volume. The optimum power flow is achieved in this work with both wind and power.

The modeling and simulation of hybrid power system with fuzzy logic controller has been demonstrated .

The issues in varying nature of the renewable energy sources are considered in the system. Uninterrupted power supply from source to load is achieved. The waveform of the load was very similar to the sinus wave form using fuzzy logic controllers. The use of the energy storage can increase the overall system reliability and stability. The experiment performed on the simulated environment and different parameters of battery and wind. The overall performance of the fuzzy logic shows its effectiveness in the field of distributed generation system.

 DOI : 10.18231/2454-9150.2018.0280

REFERENCES

[1] Xu, Yinliang, et al. "Distributed solution to DC optimal power flow with congestion management." *International Journal of Electrical Power & Energy Systems* 95 (2018): 73-82.

[2] Mohammadi, Ali, Mahdi Mehrtash, and Amin Kargarian. "Diagonal Quadratic Approximation for Decentralized Collaborative TSO+ DSO Optimal Power Flow." *IEEE Transactions on Smart Grid* (2018).

[3] Soares, Tiago, et al. "Active distribution grid management based on robust AC optimal power flow." *IEEE Transactions on Smart Grid* (2017).

[4] Badawy, Mohamed O., and Yilmaz Sozer. "Power flow management of a grid tied PV-battery system for electric vehicles charging." *IEEE Transactions on Industry Applications* 53.2 (2017): 1347-1357.

[5] Hosseinzadeh, Mehdi, and Farzad Rajaei Salmasi. "Robust optimal power management system for a hybrid AC/DC micro grid." *IEEE Transactions on Sustainable Energy* 6.3 (2015): 675-687.

[6] Madani, Ramtin, Somayeh Sojoudi, and Javad Lavaei. "Convex relaxation for optimal power flow problem: Mesh networks." *IEEE Transactions on Power Systems* 30.1 (2015): 199-211.

[7] Manyonge, Alfred Wanyama, et al. "Mathematical modelling of wind turbine in a wind energy conversion system: Power coefficient analysis." *Applied Mathematical Sciences* volume-6 Issue-91 pp: 4527-4536, 2012

[8] Tangka, Julius K., et al. "Development of an intelligent electronic module for energymanagement in wind/diesel or photovoltaic/diesel hybrid systems." *British Journal of Applied Science & Technology* volume-2 Issue-3 pp: 275, 2012

[9] Rao, Yerra Sreenivasa, A. Jaya Laxmi, and Mostafa Kazeminehad. "Modeling and control of hybrid photovoltaic-wind energy conversion system." *International Journal of Advances in Engineering & Technology* volume-3 Issue-2, pp: 192, 2012

[10] MENGİ, ONUR ÖZDAL, and İSMAİL HAKKI ALTAŞ. "Fuzzy logic control for a wind/battery renewable energy production system." *Turkish Journal of Electrical Engineering & Computer Sciences* volume-20 Issue-2 pp: 187-206, (2012)

[11]Tremblay, O., L.-A. Dessaint, "Experimental Validation of a Battery Dynamic Model for EV Applications." World Electric Vehicle Journal. Vol. 3, May 13–16, 2009

 DOI : 10.18231/2454-9150.2018.0280