Optimization of Solar-Wind Energy System Power for Battery Charging using MPPT

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***Abstract*—Power demand is ever increasing all over world. Non-renewable energy resources as coal, petroleum, natural gases and nuclear etc. are used for generation of electrical power. Electricity generation cost and investment become great issue. Renewable resources of energy as solar and wind are more popular and are natural resources available abundantly. Solar-Wind based hybrid electrical power generation system is used for power generation to overcome the above issues. The variation is always observed with solar and wind energy sources with reference to place, time and season. Solar energy and Wind energy are combined to form a solar-wind hybrid power generation system, using both of these in combination will reduce this problem mostly. It is required to get uniform and constant voltage with maximum power at output. This paper recommends optimization method of generation of power using solar-wind hybrid energy generation system used for battery charging based on MPPT (Maximum Power Point Tracking) algorithm for constant voltage method. The objective of designing this system is to increase the stability and efficiency.**

Keywords—Solar-Wind Hybrid energy system, MPPT Controller, LCD, Buck Converter, Battery.

I. INTRODUCTION

As already it is seen a generating system with a single power source non-conventional energy does not supply electricity required in a room of average consumption house and a lot least one building[1]. Renewable energy sources as solar, wind, geothermal, tidal, hydro etc. are inexhaustible by nature[2]. So, renewable energy sources can be used to provide constant loads[3]. There are number of technological developments in design, construction and implementation for generating electrical energy by using non-conventional sources as solar, wind, hydro, biomass, bio fuels and geothermal. The limitations of global resources for fossil and nuclear fuel, has necessitated an urgent search for alternative sources of energy[4]. Solar and wind energy sources are used due to global warming. These renewable energies becoming more important and pollution free. The need of clean energy generation with less environmental impact is required[5]. Solar and wind energy system is highly unreliable due to their unpredictable nature.

If one energy source is unavailable or insufficient, other energy source can compensate for the difference to meet the load demands.

Applications of photovoltaic (PV) energy with wind energy have been increased significantly due to rapid growth of power electronic techniques. These sources of energy are highly feasible alternative and high performance compared to unconventional source.

Due to environmental or day-night situations the output of these two energy resources is not certain, that one might give more power and other might give less power or no power.
To obtain stabilized voltage output from these two systems, connection of these two systems is in parallel to each other, so that if one source is not available, then the other one can balance the system. Thus, these two systems can work individually and simultaneously too[6].

II. HYBRID POWER GENERATION SYSTEM METHODOLOGY

The general hybrid power generation system mainly consists of three stages:

A. Power Generation Stage
B. Converter / Controller Stage
C. Output Stage

A. Power Generation Stage

Power is generated using wind energy, solar energy or combination of both in power generation stage.

1) Solar Energy

The term Solar Power or Solar Energy is the radiant energy emitted by the Sun. Radiant light and heat energy emitted from Sun is form of solar energy which is used in many technologies such as solar heating and photovoltaic. Photovoltaic cell converts light energy in to electric energy or current by using the photoelectric effect.

Photovoltaic cell is also known as Solar cell is a device which converts light energy in to electrical energy from sunlight. Solar panels or PV module are made up of number of Solar cells. The output of PV module is related ambient temperature and solar radiation[5].

Solar panels used in solar power systems are available as readymade by manufacturers, for example AcuTech SOLAR, SOLAR PHOTOVOLTAIC 10W MODULE, Model Number AGP12010. It is used under standard test condition (STC), the

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maximum output power is 10W. Solar panel is at STC condition of 25 ˚ C temperatures and irradiance value of 1000 W/m².

2) Wind Energy

Wind energy is a part of renewable energy system. Wind turbines are used to converts kinetic energy of wind into mechanical energy for generator, which converts mechanical energy into electricity.

Wind turbines of wind energy systems are connected to gear box. The gear box has the electrical- mechanical interface. The output of the gear box is given to the Permanent Magnet Synchronous Generator (PMSG), which produces AC output[7].

3) Solar-Wind Hybrid Energy System

Hybrid power system combines solar and wind energy. The hybrid system is combination of photovoltaic (PV) array, wind turbine[8]. Hybrid power system has several advantages over single system. In hybrid power system output of solar and wind energy system are added together in parallel in order to compensate absence of any one energy system. Solar and wind energy system can work individually or together.

The block diagram of developed model of solar and wind hybrid energy system for battery charging using MPPT shown in Fig. 1.

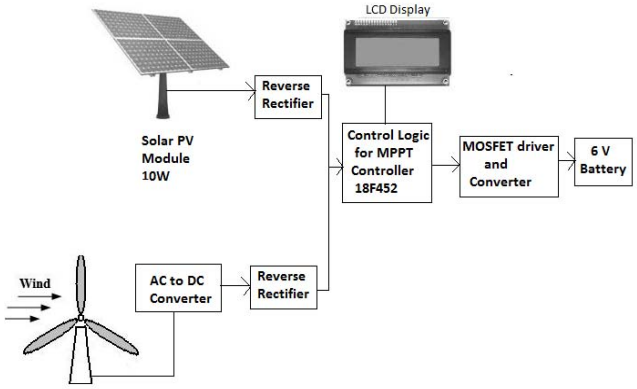

Fig. 1. Block diagram of Solar and Wind Hybrid System for Battery Charging Using MPPT

B. Conversion/ Controller stage

The two energy sources, solar and wind energy are used as input. Solar energy system gives the DC voltage at the output. Wind energy system gives AC voltage at the output and this AC voltage is converted to DC voltage.

Reverse rectifier is used as reverse voltage protection at output of two energy sources.

This combined output is given to the controller stage, at this controller stage there is MICROCHIP manufactured PIC 18F452 controller which controls the input voltage and gives the constant voltage at output side. Voltage displayed on the LCD display at maximum power (P_{max}). MPPT logic is debugging in the Controller chip with constant voltage method.

1) Maximum Power Point Tracking (MPPT)

When a solar PV module is used in the input side of the hybrid system, the operating point is decided by the load. The solar radiation varies throughout the day, so operating point changes respectively. A special method called Maximum Power Point Tracking (MPPT) is used for maximum power transfer at the output side. Maximum Power Point Tracking uses the algorithm and an electronic circuitry. Maximum power point (MPP) is extracted from the renewable source i.e., solar and wind energy[9]. The output power of the solar module is input to the algorithm. Maximum power point tracking (MPPT) used increases the efficiency of solar photovoltaic (SPV) system[10]. The proposed machine has the prominent advantages of high reliability[6]. The MPPT demands speed control which is realized using vector control of the rotor side converter[11] .

2) Algorithm for MPPT

There are various types of schemes in algorithm of MPPT that are implemented for maximum power transfer. The schemes are hill climbing method, incremental conductance method, constant voltage method, modified hill climbing method, system ossilation method and ripple correlation method. The constant voltage method is used in this methodology for MPPT.

The flow chart of constant voltage method for MPPT is as shown in Fig. 2.

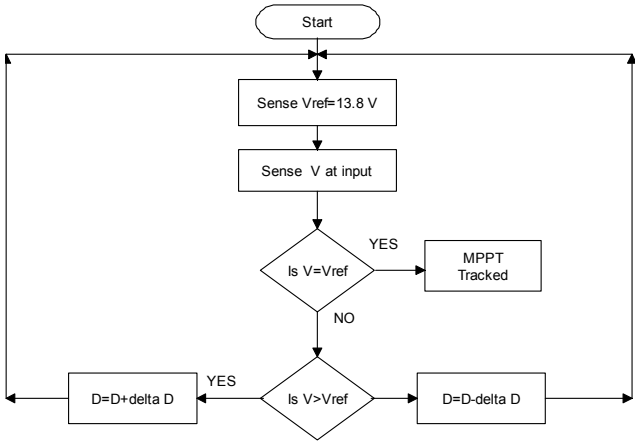

Fig. 2. Flow chart of constant voltage method

3) Constant Voltage Method

The ratio of PV module array voltage and an open circuit voltage is nearly constant, independent of any external conditions is known as constant voltage method.

The sensed PV array voltage is compared with the reference voltage to generate an error signal, which controls the duty cycles.

C. Output Stage

The controller gives the constant output voltage irrespective of any input voltage to the MOSFET driver circuitry. At the output side MOSFET driver circuitry gives the voltage to charge the Battery. It consists of main and auxiliary battery storage system which has higher energy yield as compared to conventional energy storage system[12].

III. Experimental Setup

The hardware module of solar-wind hybrid energy system using MPPT control is shown in Fig. 3.

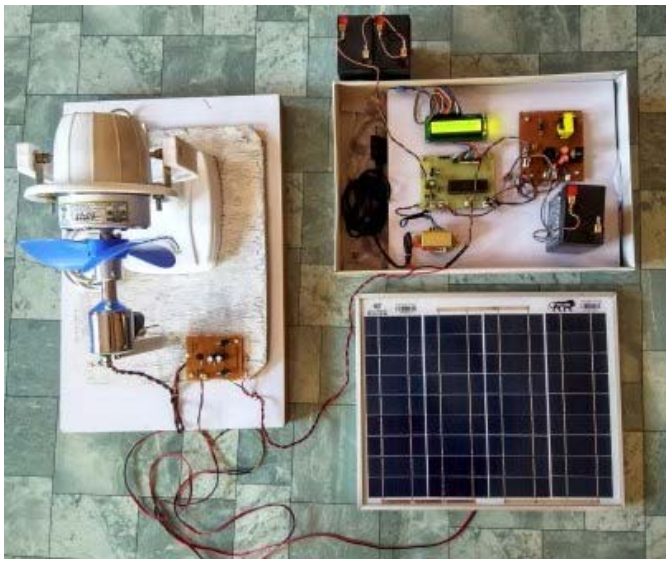

Fig. 3. Experimental Setup of Solar-Wind Hybrid Energy System using MPPT

IV. Experimental Results

The observed values of electrical parameters of solar-wind hybrid energy system using MPPT control is shown in Table I.

TABLE I. Values of Electrical Parameters for Solar-Wind Hybrid Power System Using MPPT

No. of Reading	Parameters	
	Electrical Parameters	***Value***
1.	Maximum Power (P_{max})	10 W
2.	Voltage at Pmax (V_{mpp})	13.8 V
3.	Open-circuit voltage (V_{oc})	22 V

V. Conclusion

From hybrid system the generation of electric power is cost effective and efficient. Use of MPPT algorithm will make it flexible by giving stable voltage and maximum power which shown in the Table I, the values obtained for P_{max}, V_{mpp} and V_{oc}. If more energy is required the system can be extended by connecting one or more batteries or wind turbines, means system is scalable. This makes the system useful for practical purpose. Energy generation due to individual energy source problem is eliminated by hybrid system. This system improves reliability and performance by using MPPT.

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