PV & Wind Hybrid Output Power Generation And Control Fluctuation By Using Battery Energy Storage Station

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Abstract: - In this paper, a smoothing control method and a novel real-time Battery Energy Storage Station (BESS) based power allocation are proposed to reduce wind/PV hybrid output power fluctuations and regulating battery SOC under the typical conditions. The BESS is the present classic means of smoothing wind - or solar power generation fluctuations. Such BESS-based hybrid power systems require a suitable control strategy that can effectively regulate power output levels and battery state of charge (SOC). To improve smoothing performance of the wind/PV/BESS hybrid power generation and the effectiveness of battery SOC control, the wind/PV/BESS hybrid power generation simulation analysis are undertaken to present the results.

KEYWORDS: - Adaptive smoothing control, Battery Energy Storage Station (BESS), Photovoltaic(PV), solar power generation, State Of Charge (SOC), wind power generation.

1. INTRODUCTION

In recent years, electricity generation by photovoltaic (PV) or wind power (WP) has received considerable attention worldwide. The State Grid Corporation of China (SGCC) is building the National Wind/PV/battery energy storage station(BESS) and Transmission Joint demonstration project and it is located in the region of Zhangbei, Hebei, China. The Zhangbei belongs to one of the country's 10 million kilowatts of wind power base. The demonstration project is scheduled in three stages. Now, it is in the first stage and at the end of December, 2011, a 100-MW wind farm, a 40-MW PV farm, and 14-MW/63-MWh lithium–ion BESS have been built at Zhangbei. The battery energy storage system can provide flexible energy management solutions that can improve the power quality of renewable-energy hybrid power generation systems. To that end, several control strategies and configurations for hybrid energy storage systems, such as a battery energy storage system [1]–[5], a superconducting magnetic energy system (SMES) [6], a flywheel energy system (FES) [7], an energy capacitor system (ECS) [8] and a fuel cell/electrolyze hybrid system have been proposed to smooth wind power fluctuation or enhance power quality. Thanks to the rapid Fig. 7. Wind/PV/BESS hybrid power generation system. development of batteries, battery energy storage systems recently have begun to be utilized for multiple applications such as frequency regulation, grid stabilization, transmission loss reduction, diminished congestion, increased reliability, wind and solar energy smoothing, spinning reserve, peak-shaving, load levelling, uninterruptible power sources, grid services, electric vehicle (EV) charging stations, and others. These days, the issue of how power fluctuations in PV and wind power generation are to be smoothed has attracted widespread interest and attention. And even as this issue isbeing resolved, another one, that of the application of an energy storage system such as BESS, has arisen. When using BESS to control PV and wind power fluctuations, there is a trade-off between battery effort and the degree of smoothness. That is, if one is willing to accept a less smooth output, the battery can be spared some effort. Thus far, although various effective BESS-based methods of smoothing power fluctuations in renewable power generation systems have been proposed [2], [3], [5], smoothing targets for grid-connected wind and PV farms generally have not been formulated. Smoothing control by way of power fluctuation rate limits, for such systems, has rarely even been discussed. The control strategies published in [1]–[5] were formulated mainlyfor small-scale BESS-based smoothing; hence, they did notconsider power allocation among several BESS. A suitableand effective control strategy for large-scale BESS, therefore, remains an urgent necessity. In the present study, under the assumptions that the capacities of the WP and PV hybrid generation system (WPPVGS) and BESS had already been determined and that we do not have ability to adjust the WPPVGS output power, a large-scale BESS was used to smooth the WPPVGS output power fluctuation.

2. EXISTING SYSTEM

Energy storage is a key issue for successful market implementation of concentrated solar power technology. In hole system the fluctuation is more because of this the output of power regulation is less, so the equipment get damaged, Advanced thermal storage technology based on phase change materials has been identified to meet the requirements of solar steam generating plants. Energy storage systems using latent heat have often been proposed, but never carried out on a large scale due to low thermal conductivity of salt systems to be used as phase change materials (PCM) and non efficient internal heat exchange and cycling problems. The DISTOR approach to solve the heat transfer limitations includes several innovative aspects: Advanced storage materials based on micro-encapsulation, reflux heat transfer and a new adapted design concept.

3. PROPOSED SYSTEM

These days, the issue of how power fluctuations in PV and wind power generation are to be smoothed has attracted widespread interest and attention. And even as this issue is being resolved, another one, that of the application of an energy storage system such as BESS, has arisen. In older system the fluctuation is more. It affects the power generation. To overcome this we can use battery energy storage station as we use battery storage system the fluctuation get reduced and the equipment will be safe. As we are not using relay circuit, We get the power generated from both solar and wind, so that no energy loss.

The basic block diagram involved in the proposed work is shown below Fig 1 and Fig 2 with transmitter and receiver sections respectively.

The sensor's outputs are given to PIC processor which is connected to WSN (wireless communication network) to communicate the data between PC and PIC. When the intensity of energy from the solar panel is less, then the panel can be shifted automatically upwards. If the energy from the solar panel is less, then the energy generated by the windmill is used to drive the device. The whole system is placed in the ocean.

The hardware requirements required to implement the proposed system are PIC Processor, WSN, PC, ADC, LDR, Voltage Sensor, Solar Panel, Wind Mill, Current Sensor, Temperature Sensor, Battery, Uart. The software requirements are pic c Compiler, Embedded C,Visual Studio.

Light Dependent Resistor or a Photo Resistor

A **Light Dependent Resistor** (LDR) or a photo resistor is a device which is used to check the intensity of light. If the light intensity is lower than 27^0c.It intimates the controller that it's dark night on this time the power will be generated only by the wind.LDR resistivity is a function of the incident electromagnetic radiation. Hence, they are light sensitive devices. They are also called as photo conductors, photo conductive cells or simply photocells. They are made up of semiconductor materials having high resistance. There are many different symbols used to indicate a **LDR**, one of the most commonly used symbol is shown in the figure below.

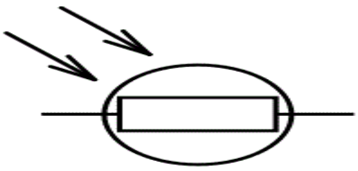

Fig 1 :Light Dependent Resistor

A **light dependent resistor** works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the materials conductivity (Hence resistivity) reduces when light is absorbed by the material. When light falls i.e. when the photons fall on the device, the electrons in the valence band of the semiconductor material are excited to the conduction band. These photons in the incident light should have energy greater than the band gap of the semiconductor material to make the electrons jump from the valence band to the conduction band.

Hence when light having enough energy is incident on the device more & more electrons are excited to the conduction band which results in large number of charge carriers. The result of this process is more and more current starts flowing and hence it is said that the resistance of the device has decreased.

Characteristics of LDR

LDR's are light dependent devices whose resistance decreases when light falls on them and increases in the dark. When a **light dependent resistor** is kept in dark, its resistance is very high. This resistance is called as dark resistance. It can be as high as 1012 Ω. And if the device is allowed to absorb light its resistance will decrease drastically. If a constant voltage is applied to it and intensity of light is increased the current starts increasing. Figure below shows resistance vs. illumination

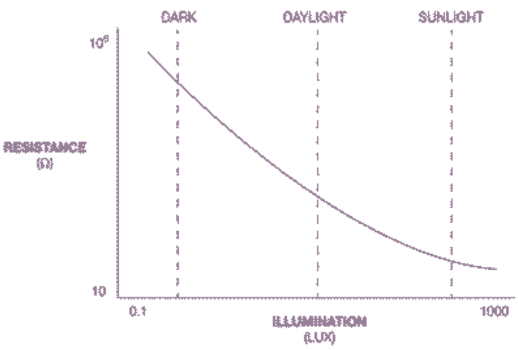

Figure 1 The resistance of a photoresistor falls dramatically as you illuminate it.

Fig 2- Curve for a particular of LDR

Photocells or LDR's are non linear devices. There sensitivity varies with the wavelength of light incident on them. Some photocells might not at all response to a certain range of wavelengths. Based on the material used different cells have different spectral response curves. When light is incident on a photocell it usually takes about 8 to 12ms for the change in resistance to take place, while it takes seconds for the resistance to rise back again to its initial value after removal of light. This phenomenon is called as resistance recovery rate. This property is used in audio compressors. Also, **LDR**'s are less sensitive than photo diodes and photo transistor. (A photo diode and a photocell (LDR) are not the same, a photo-diode is a p-n junction semiconductor device that converts light to electricity, whereas a photocell is a passive device, there is no p-n junction in this nor it "converts" light to electricity).

Types of Light Dependent Resistors

Based on the materials used they are classified as: i) Intrinsic photo resistors (Un doped semiconductor): These are pure semiconductor materials such as silicon or germanium. Electrons get excited from valance band to conduction band when photons of enough energy falls on it and number charge carriers increases.

ii) Extrinsic photo resistors: These are semiconductor materials doped with impurities which are called as dopants. Theses dopants create new energy bands above the valence band which are filled with electrons. Hence this reduces the band gap and less energy is required in exciting them. Extrinsic photo resistors is generally used for long wavelengths.

Construction of a Photocell

The structure of a light dependent resistor consists of a light sensitive material which is deposited on an insulating substrate such as ceramic. The material is deposited in zigzag pattern in order to obtain the desired resistance & power rating. This zigzag area separates the metal deposited areas into two regions. Then the ohmic contacts are made on the either sides of the area. The resistances of these contacts should be as less as possible to make sure that the resistance mainly changes due to the effect of light only. Materials normally used are cadmium sulphide, cadmium selenide, indiumantimonide and cadmium sulphonide. The use of lead and cadmium is avoided as they are harmful to the environment.

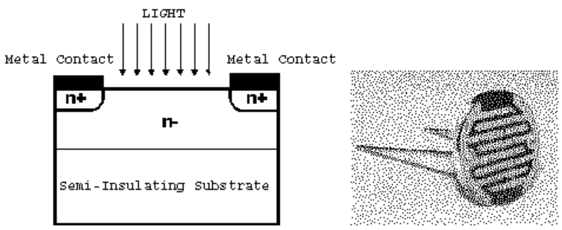

Fig 3: Construction Of Photocell

Applications of LDR

LDR's have low cost and simple structure. They are often used as light sensors. They are used when there is a need to detect absences or presences of light like in a camera light meter. Used in street lamps, alarm clock, burglar alarm circuits, light intensity meters, for counting the packages moving on a conveyor belt, etc.

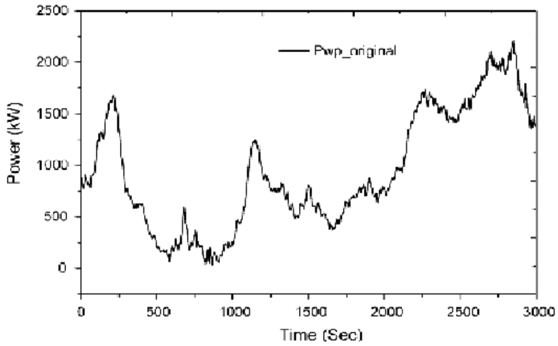

Fig 4: Power generation of PV before using SOC

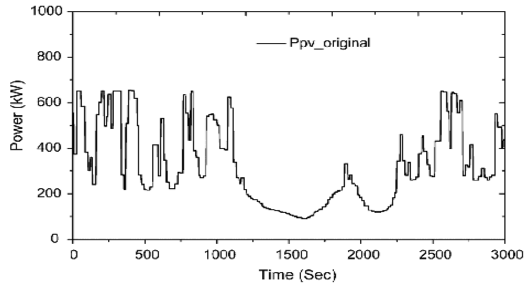

Fig 5: Power of generation of Wind before using SOC

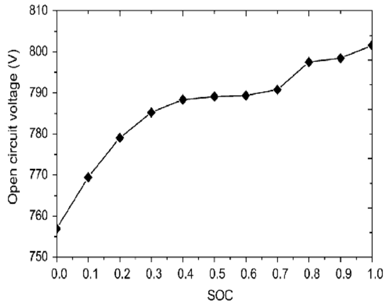

Fig 6: Power production of PV&Wind after using SOC

Block Diagram

Transmitter Section:

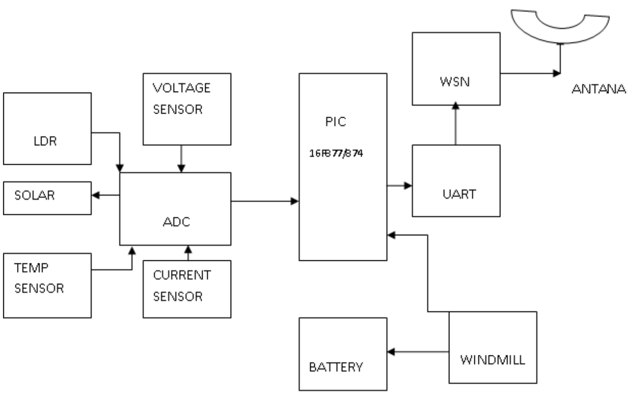

Fig 7: Transmitter section

Receiver Section:

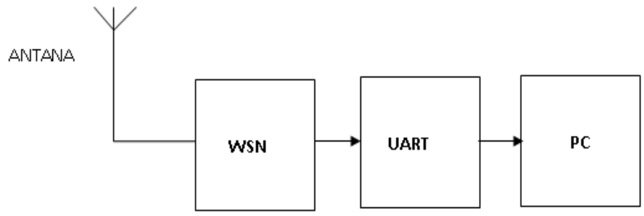

Fig 8: Receiver Section

CONCLUSION

The disadvantage of PV and wind power generation is their unstable power output, which can impact negatively on utility- and micro-grid operations. One means of solving this problem is to integrate PVGS and WPGS with a BESS. For such hy-brid generation systems, control strategies for efficient power dispatch need to be developed. Therefore, in this paper, a novel SOC-based control strategy for smoothing the output fluctuation. of a WP and PV hybrid generation system has been proposed. Additionally, the SOC feedback control strategy and the real- time power allocation method for timely regulation of battery power and energy are presented. Simulation results demonstrate that the proposed control strategy can manage BESS power and SOC within a specified target region while smoothing PVGS and WPGS outputs. At present, how to control the SOC of the energy storage system is an ongoing research topic. We also need to combine the characteristics of the battery, and do further research and exploration. From the present research results, it can be seen that by using the proposed control method, the SOC of each battery energy storage unit can gradually move toward 50% with the increase of control time although the initial SOC of the en- ergy storage unit is different.It is also considered that this control method can make the storage unit share the load as consistently as possible, so as to achieve the effect of extending the service life of the energy storage system and, therefore, can delay the accelerated decay of the battery performance. Moreover, it should be noted that some filtering on the BESS charge and discharge power have been achieved by using a power fluctuation rate constraint as the smoothing control target to prevent excessive excursions to "chase down" every PV or wind power output fluctuation. In addition, this paper was mainly focused on the control strategies of BESS and smoothing based on battery capacity established conditions. Another significant issue is the means by which an appropriate battery capacity for this application is to be determined. The power control strategies for large-scale wind/PV/BESS hybrid power systems taking into account the optimum capacity of BESS and battery aging will be discussed in the near future combined with smoothing control application of wind and PV power generations.

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