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Coordination and Control of Solar-Wind Hybrid System for Remote Telecom Towers Under various Climatic Conditions

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ABSTRACT__*Most of the Telecom towers in India are located at remote areas where supplies for these towers are needed to be supplied by using Diesel generators mostly. These system are highly costly and emission of green house gases is evitable thus by using renewable resources the demand for the towers can be satisfied partially so that the cost of operation of telecom towers can be reduced and emission of green house gases and harmful gases can be reduced to an extent. A hybrid generation system consist photovoltaic (PV), wind turbine (WT) and Battery is presented to supply stable power to rural residential loads. DC/DC converters are used to control the power flow to the load and Maximum Power Point Tracker (MPPT) is used for maximum power extraction from the solar photovoltaic systems and wind turbine. To compensate power fluctuation of renewable energy MPPT method is used. When PV and WT generate power is lower than demand power, the Battery is controlled to discharge power to complete the difference of supply and demand power. If PV and WT generate power is higher than demand power, the Battery is controlled to charge power. The system was simulated by using MATLAB/Simulink and a control system is designed using ARM Microcontroller for energy management. The simulation results show the proposed system can compensate power fluctuation.*

Keywords: Renewable energy, PV solar power systems, Hybrid photovoltaic - windTurbine, MPPT, MATLAB

1.INTRODUCTION

India is endowed with abundant renewable energy resources, the significant ones being solar energy, biomass, wind, small and large hydropower with potential for hydrogen fuel, geothermal and ocean energies. Except for large scale hydropower which serves as a major source of electricity, the current state of exploitation and utilization of the renewable energy resources in the country is very low, limited largely to demonstration and pilot projects. The main constraints in the rapid development and diffusion of technologies for the exploitation and utilization of renewable energy resources in the country are the absence of market and the lack of appropriate policy, regulatory and institutional framework to stimulate demand and attract investors. The proposed consist of a solar panel with MPPT tracking technique. The power produced by the solar and windmill is used to satisfy the partial demand of the Telecom towers. The produced power is stored in a battery for continuous controlling system by using the controlling unit. The controlling system consists of GSM modem to inform the controller about the present situation in the field.

If the PV cell is in unsuitable condition to produce required power to produce power for satisfy the load the power from the grid and diesel is used to satisfy the load. Network based machine controlling or monitoring process are now a day's very use full in various industries. Based on Internet and Wireless sensor networks [5], [6] various types of monitoring as well as controlling systems are available but the supporting protocols, internet connection availability requirements makes cost of the system high. When choosing a wireless technology for monitoring and control process, network coverage range is essential So GSM is an apt one for the system for remote monitoring and control process with low cost and alsoProvides a good signal transmission range. In section two we go through a few topics necessary in understanding this work and the system in general. Section three shows the research methodology adopted while analyzing the various mechanisms of the system. Finally, we conclude the document by presenting remarks and suggestion for future work to be done.

2, CONTROLLING UNIT

To develop a system for monitoring and irrigation purpose various key points needed to be considered such as operating voltage and temperature range. Because the system is operated under three phase supply, as well as motor room temperature may be increased high in summer season. Therefore the system is developed in such a way that it can tolerate voltage changes and adapt to various environmental conditions. The Fig 1 shows the developed system for remote monitoring and control purpose. The system will monitor the three phase power supply availability and send the measured phase voltage of each phase to user mobile. GSM network is utilized to communicate between the system and user mobile. This system uses wavecom modem. This can operate at dual band 900/1800MHz. It is controlled by firmware through a set of AT commands [6], [7].

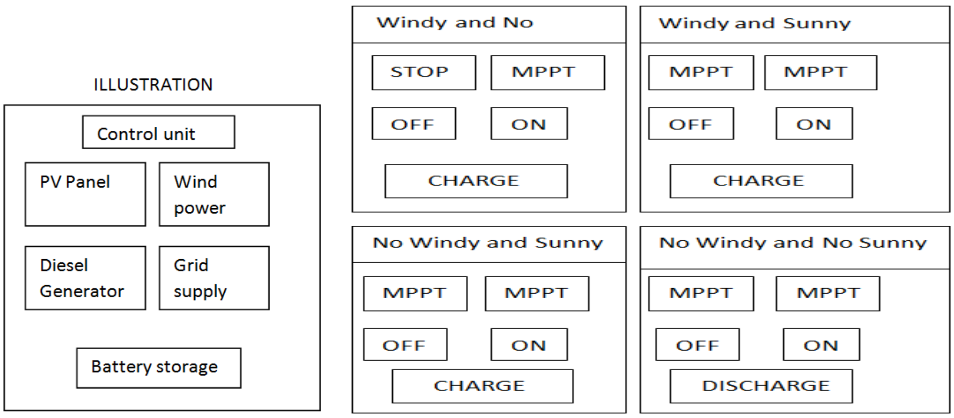

Figure 1: Describes the various sources connected to the system and operation of various sources according to the various climatic conditions

In this paper we have simulated the working of system under four climatic conditions and control System is designed such that it optmizely uses the combinations of various power source available to satisfy the load. The system normally gets the supply from the grid connected to the system. In case during the failure of the grid the alternative Diesel generators are used to satisfy the load. Here the conditions are assumed such that Grid is always in on situation and climatic conditions are affected only for the renewable sources. The control system uses the Hybrid Pv-Wind system and battery is available such that it charges and discharges during the desired situations.

3, SYSTEM INTERFACE

This section gives a brief description about interfacing the micro controller with the sensors and Other devices. This system uses LPC2148 [8] board and this board consists of is 16-bit/32-bit ARM7TDMI-S microcontroller.ARM7-TDMI (Thumb Debug Multiplier ICE processor) is a 32-bit CPU. The ARM architecture is based on Reduced Instruction Set Computer (RISC) principles. The RISC instruction set and related decode mechanism are much simpler than those of Complex Instruction Set Computer (CISC) designs. It has Features such as 3-Stage Instruction pipeline, Von-Neumann Architecture, Average Instruction cycle time is ~32ns with 60 MHz, Operation Switch between ARM stage and the THUMB stage. LPC 2148 has an On-chip integrated oscillator with an external crystal from 1 to 25 MHz in-System Programming/In-Application Programming (ISP/IAP) via on-chip boot loader

Software. Single flash sector or full chip erase in 400 ms and programming of 256 B in 1 ms. Embedded ICE and Embedded Trace interfaces offer real-time debugging with the on-chip Real Monitor software and high-speed tracing of instruction execution. Vectored Interrupt Controller (VIC) with configurable priorities and vector addresses. Power saving modes includes idle and Power-down. Processor wakes-up from Power-down mode via external interrupt BOD. CPU operating voltage range from 3.0 V to 3.6 V (3.3 V ± 10 %) with 5 V tolerant I/O pads based on ARM7-TDMI processor. IAR Embedded work bench is used to develop program codes for this work [13]. Codes are written in c language and it is compiled by IARWB. Flash magic software is used to fuse the programs in to the ARM7- TDMSI processor.

4,HYBRID SYSTEM

The proposed system can provide a reliable supply to the load and handle the load fluctuations since it uses three energy resources. Solar energy is maximum at the day times and wind energy is maximum at the night times, So that at least one will be operating throughout day to supply power to the load.

Figure 2: Describes the Basic Block diagram of the Hybrid system

Further the system consist of battery i.e. EDLC for storage of power during excess generation of power and discharge during low generation. This makes the system standalone and reliable to handle home and industrial applications. The system further uses MPPT technique for compensating power fluctuations and to synchronies the power produced by both windmill and PV cells.

4.1 Implementing flow

The proposed system is simulated with the help of the Matlab software. Here a hybrid power plant is showed, it consists a PV Panel, Wind mill and EDLC with separate DC-DC conversion and MPPT.

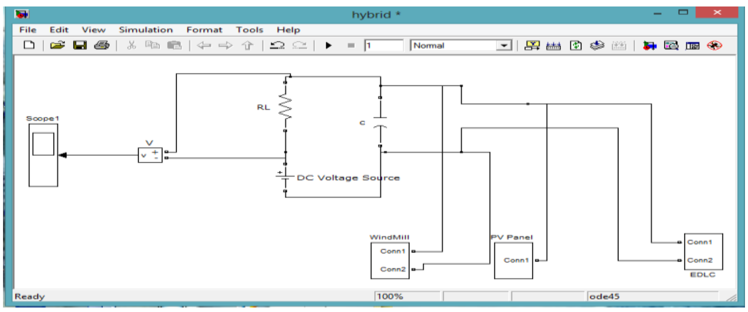

Figure 3: Simulink representation of Hybrid Solar/Windmill power plant with storage bank.

4.1,PV Model System

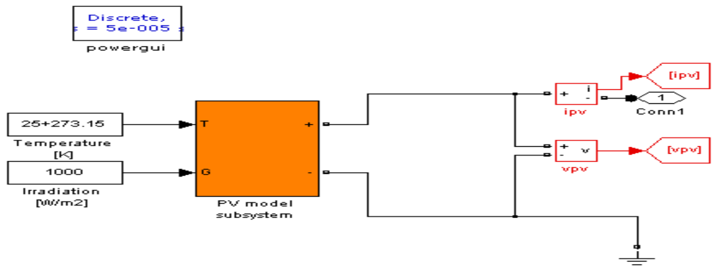

Figure 4: Simulink model for PV panel with variable Irradiation factor.

The performance of a solar or photovoltaic (PV) cell is measured in terms of its efficiency at converting sunlight into electricity [2]. There are a variety of solar cell materials available, which vary in conversion efficiency. A solar cell consists of semiconductor materials. Silicon remains the most popular material for solar cells. The types of solar cells are classified as; crystalline, polycrystalline, amorphous thin films, and multi-junction concentrator cells. PV Model (Fig 4) is showed here input for PV is temperature and irradiation, as per the temperature range the output of PV is varied.

4.2,Windmill Model System

Wind turbines using a doubly-fed induction generator (DFIG) consist of a wound rotor induction generator and an AC/DC/AC IGBT-based PWM converter modeled by voltage sources. The stator winding is connected directly to the 50 Hz grid while the rotor is fed at variable frequency through the AC/DC/AC converter. The DFIG technology allows extracting maximum energy from the wind for low wind speeds by optimizing the turbine speed, while minimizing mechanical stresses on the turbine during gusts of wind. The wind speed is maintained constant at 15 m/s. The control system uses a torque controller in order to maintain the speed at 1.2 pu.

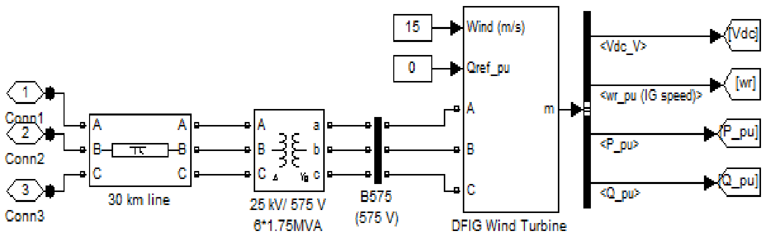

Figure 5: Simulink mode for Windmill with variable wind speed

5, RESULTS

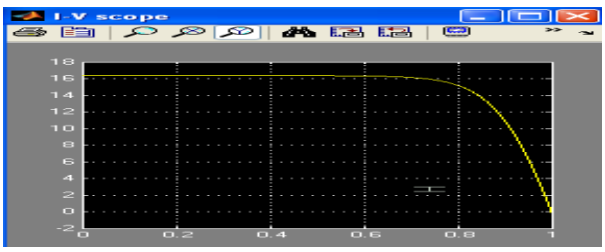

Figure 6: Current Vs voltage scope is showed here for single panel.

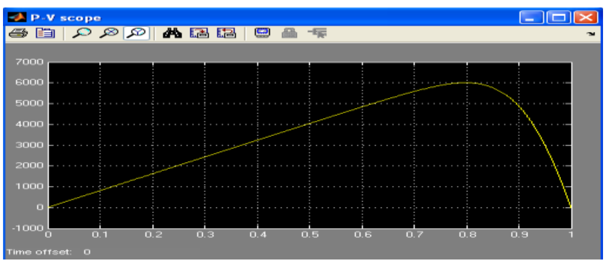

Figure 7: Power scope for single panel

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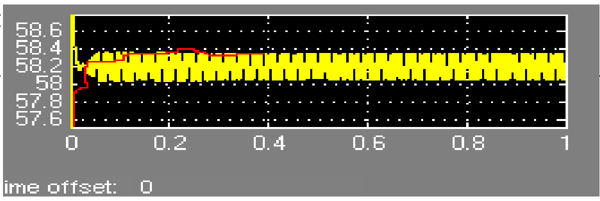

Figure 8: Output of PV voltage after MPPT

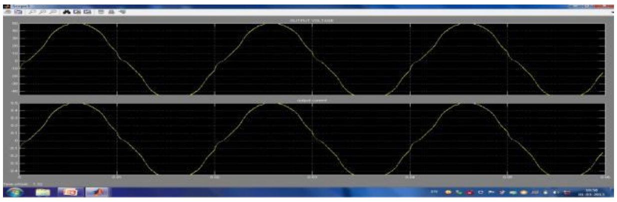

Figure 9: Output from the Windmill

Figure 10: Battery output after pi controller

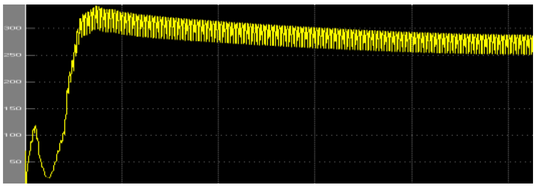

Figure 11: Final output with MPPT

SOLAR POWER	WIND POWER	EB SUPPLY	CONTROLLER	BATTERY
12v	12v	ON	Solar Power-ON Wind Power-FF EB Power OFF	12v
< 6 v	12v	ON	Solar Power-OFF Wind Power-ON EB Power OFF	12V
12v	< 6 v	ON	Solar Power-ON Wind Power-OFF EB Power OFF	12V
< 6 v	< 6 v	ON	Solar Power-OFF Wind Power-OFF EB Power-ON	12V
< 6 v	< 6 v	OFF	Solar Power-ON Wind Power-OFF EB Power- OFF	12V
12v	12v	ON	Solar Power-OFF Wind Power-OFF EB Power- ON	< 9 v
12v	< 6 v	OFF	Solar Power-ON Wind Power-OFF EB Power- OFF	< 9 v

Table 1: Set of Rules Used during the simulation and real time verification to check reliability of the System.

5,CONCLUSION:

This paper presets the coordination control between various power sources and control system is designed such that it optimize the usage of diesel power source to save the operation cost and also helps in reducing the emission of green house gases. Further this system in real-time will help in reducing the operation cost of the telecom tower. Since tower have the large area to accompany the solar and wind turbines. The simulations results were discussed along with the real-time control unit. The system can be improved by using intelligent control system such as fuzzy to improve the controlling capability of the system.

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