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Control Strategies of Hybrid Systems WIND/PHOTOVOLTAIC using Advanced Techniques in Maximum Power Point Tracking

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Abstract:

An In this paper, an efficient energy management scheme for Hybrid system is elaborated. The proposed a Hybrid system constrict from Wind turbine and solar energy offers a clean energy solution, The main task of the control loop is to extract and track maximum power from hybrid system with sufficient tracking behavior we suggested a deflection angles of the wind turbine To track the operational point at which the maximum power can be extracted from wind system and generating system under continuously changing climatic conditions, using Bi-Directional Converter for Battery Charging and discharge the battery based on the surplus and deficit of power. When there is an excess of energy, To optimize the power produced in a wind turbine, the speed of the turbine should vary with the wind speed. A simple control method is proposed that will allow an induction machine to run a turbine at its maximum power coefficient a straightforward control technique that is also cost-effective has been presented. Along with modeling results that show the system's effectiveness, the whole hybrid system is presented. MATLAB/Simulink is used to create a software simulation model.

Keywords: “PV” system, Wind Energy, Hybrid System, Bitch angle.

1. Introduction

Renewable energy sources are constantly being developed as a result of the critical state of industrial fuels, such as oil, gas, and others. This is the reason why renewable energy sources are more significant today [1]. Other factors include benefits like plentiful availability in nature, eco-friendliness, and recyclable materials. There are numerous renewable energy sources, including solar, wind, hydro, and tidal. The two renewable energy sources with the fastest global growth rates are solar and wind power. Energy is converted using wind and PV cells without any emissions of pollutants [2, 3].

When a solar PV system is combined with other energy sources, such as diesel generators or renewable energy sources like wind, the resulting system is referred to as a "hybrid system".

A block diagram of a hybrid system is shown in Figure 1. Different converters are utilized in these systems to convert energy into either DC voltage or AC voltage depending on the type of sources integrated with the solar PV panels [4]. A maximum power point tracker (MPPT) is utilized in all PV systems, including hybrid systems, to extract the maximum power from the PV arrays. Although MPPT is not a requirement for solar PV systems, it can enhance the overall system's efficiency [5].in Figure (1) show construction Hybrid system from PV and Wind turbine [3]. This paper is presented as follows. In Section II, a description Proposed Hybrid Energy System and a mathematical model of the system is discussed. In

Section III, Vector oriented control of the Bi-Directional Converter for Battery Charging and discharging. In section VI, simulation results are presented. Finally, Section VII presents the conclusions

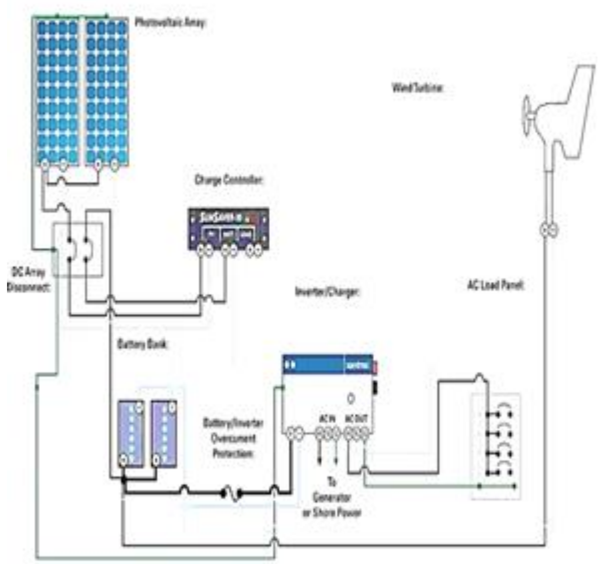


Figure 1 Hybrid system construction

2. Proposed Hybrid Energy System

In this paper, a model of a wind-photovoltaic hybrid power generation system is studied and simulated. As individual power generation systems are not totally reliable, a hybrid system is more advantageous. When one of the systems is shutdown, the other can provide power. In Figure 2 view the following block diagram shows the entire hybrid system using in this research. The hybrid system consists of the wind and solar energy systems. The PV energy system is designed using maximum power point tracking systems. Solar energy harvesting converts the incident light on the PV cells into electrical energy.

The maximum power point tracking system with the Perturb & absorb algorithm is used to extract the most power possible from the PV modules. The ac-dc converter is used to convert alternating current voltage to direct current voltage [7, 8]. The wind energy system includes a wind turbine, gearbox, generator, and an AC - DC converter. Wind energy is converted to rotational mechanical energy by the wind turbine, and the mechanical energy available at the turbine shaft is converted to electrical energy by a generator. A Maximum power point tracking mechanism is used to extract the maximum power from the wind system.

Both energy systems use a bi-directional converter to charge a battery. Both energy systems are used to charge a battery using a bi-directional converter. Hybrid generating systems that use more than one power source can considerably enhance the predictability of load needs throughout time. A hybrid system can achieve even higher generating capacities. To convert the PV system's energy output to storage energy and deliver constant power from the wind turbine, an efficient energy storage process is needed, which the battery bank can provide.

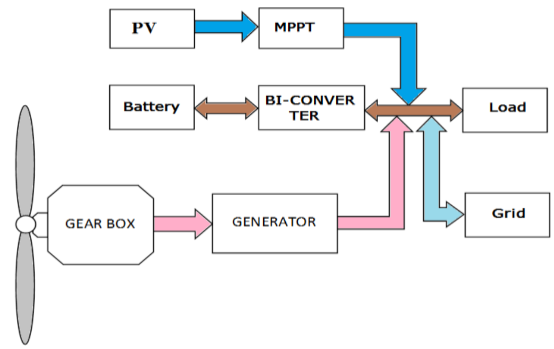


Figure 2 Block diagram of hybrid system

2.1 Solar energy

A solar cell is essentially a p-n junction made-up in a thin wafer of semiconductor [6]. Photovoltaic effect can be directly converting the electromagnetic radiation of solar energy into electricity. Being exposed to the daylight, photons with energy bigger than the band-gap energy of the PV cells makes certain electron-hole pairs comparative to the incident light. In Figure 3 the equivalent circuit of a PV cell is shown below [6].

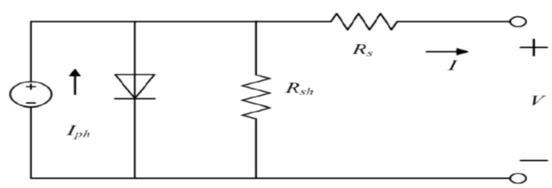
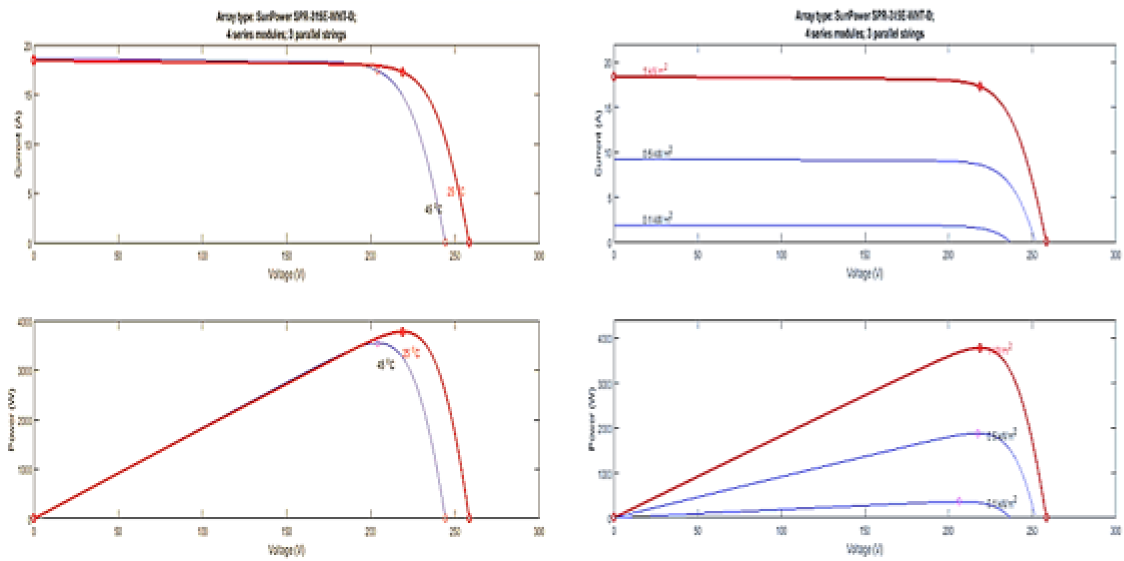


Figure 3 PV Cell Modeled As Diode Circuit.

The current source (Iph) is representing the cell photocurrent and (Rs, Rash) are series resistances and intrinsic shunt of one cell, respectively. Generally the measure Rsh of is very slight and the measure of Rs is very big, subsequently they might ignore to shorten the analysis.

The output power and current characteristics vs. time of the proposed Canadian Solar module CS6P-255P is shown in, Figure 4 varying temperature and irradiance.

The proposed array sizing is 10 series modules; and 4 parallel strings to obtain around 10.1472 kW power. the output characteristics of PV module with varies temperature [0 25 50] at constant irradiance (1000 w/m). The power output reduces with the increasing in temperature at same irradiance. On the other hand, Figure 4 shows the output characteristics of PV module with varying irradiance [200 400 600 800 1000] at the constant temperature (25C) .The power output increase with the increases in irradiance at a constant temperature. In cases, the current output increases and the voltage output also increases.



A- at different temperature condition **B- at different irradiation level.**

Figure 4 photovoltaic characteristics profiles A- at different temperature condition B- at different irradiation level.

2.2 Wind energy

In recent decades, wind energy has been used to generate electricity. Wind energy, or wind power, is created using a wind turbine, a device that channels the power of the wind to generate electricity.

The wind blows the blades of the turbine, which are attached to a rotor. The rotor then spins a generator electrical from wind. The most common type of wind turbine is the ‘Horizontal Axis Wind Turbine’ (HAWT). It is referred to as a horizontal axis as the rotating axis lies horizontally (As show in figure 5 [9,10] .this type from wind turbine using in this work , needs to point directly into the wind to operate at maximum efficiency, and the whole head is designed to turn to face the wind. As the wind changes direction, so the head must turn (or ‘yaw’) to stay pointing into the wind.

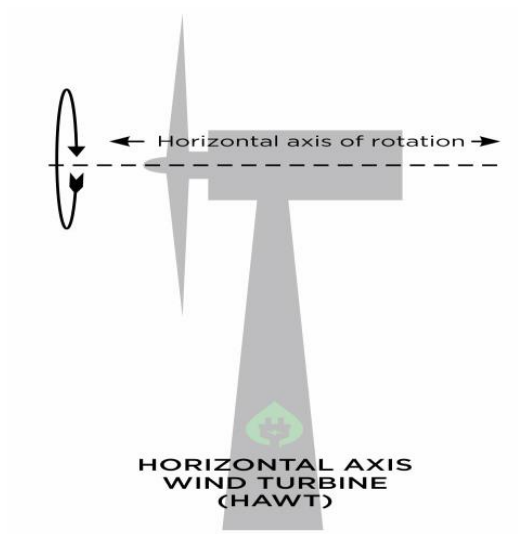


Figure 5 HAWT [13].

The wind energy conversion system is of mainly two types, namely the fixed speed and variable speed operation systems. As compared to the fixed speed wind generation systems, the variable speed wind generation systems produce more power [10] and provide less stress on the generator shaft, as the shaft speed can vary with the variation of wind speed. The variable speed WECS is also cost effective and provide simple pitch control for the turbine [9]. That is why, the variable

Currently Smart Grid technology is a hot topic for the power researchers. In view of the smart grid technology, a tentative block diagram of the future WECS has been depicted in Fig. 7. A wind turbine having the ability of variable sweeping area, or integrated multiple wind turbines, or efficient single wind turbine will be connected with the higher poles generator without any gearbox. The full power electronics conversion with energy storage system will help run the whole system reliably.

- **Dc generation techniques**

In conventional DC machines, the field is on the stator and the armature is on the rotor. The stator comprises a number of poles which are excited either by permanent magnets or by DC field windings. If the machine is electrically excited, it tends to follow the shunt wound DC generator concept.

An example of the DC wind generator system is illustrated in Fig. 6[11].

It consists of a wind turbine, a DC generator, an insulated gate bipolar transistor (IGBT) inverter, a controller, a transformer and a power grid. For shunt wound DC generators, the field current (and thus magnetic field) increases with operational speed whilst the actual speed of the wind turbine is determined by the balance between the WT drive torque and the load torque.

The rotor includes conductors wound on an armature which are connected to a split-slip ring commentator. Electrical power is extracted through brushes connecting the commentator which is used to rectify the generated AC power into DC output. Clearly, they require regular maintenance and are relatively costly due to the use of commentators and brushes.

In general, these DC WTGs are unusual in wind turbine applications except in low power demand situations [11, 12] where the load is physically close to the wind turbine, in heating applications or in battery charging [14].

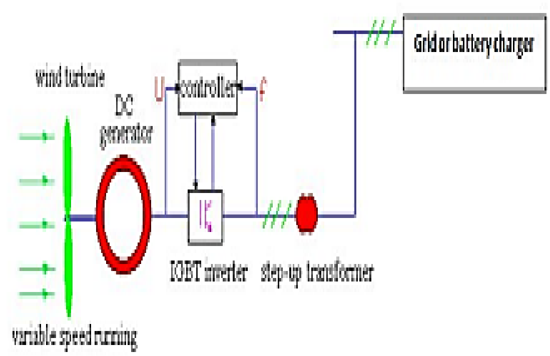


Figure 6 Schematic of a DC generator system

3. Bi-Directional Converter for Battery Charging

As previously stated, the bidirectional converter has many applications, and in this work, the converter is used to charge and discharge the battery based on the surplus and deficit of power. When there is an excess of energy, i.e. when supply exceeds demand, the battery is charged, allowing the converter to operate in the forward direction. When there is a power deficit, i.e. when supply is less than demand, the battery begins to discharge, supplying the power deficit to the load.

This necessitates the use of the converter in reverse. A bidirectional converter is used to charge and discharge the battery. Figure 6 show construction bi-directional converters [15].

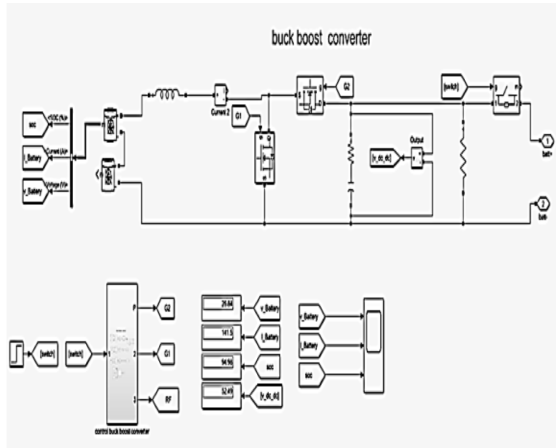


Figure 7 Bi-**Directional Converters**.

Equations A “Battery Energy Storage system” (BESS) is essential as the converting of “Alternating Current” AC to “Direct Current” DC is done by BESS; it consists of PE devices as a control system and batteries. Here, the role of battery is the converting of electrical energy from source to chemical energy to battery for storage purpose.

By using DC power Batteries are charged and discharged. Bi-directional DC-DC PE converter regulates power flow between batteries and energy systems. BESS of Nickel Metal Hydride are significant kinds of energy storage technique. It has offered a better solution for applications of energy storage such as long cycle life, high energy density, charge or discharge efficiency is high, when compared to Metal Hydride batteries are better in all qualities and have low maintenance necessities in the Lead-Acid batteries [15].

4. Results and analysis

Provides a brief overview of the simulation of the Hybrid PV system and wind turbine, as well as the parameter values. The findings and discussion are presented in, There are three subsections in this section. The first subsection displays and discusses the steady-state result at nominal conditions, where the battery plays no role.

The results are given in the second subsection under load variation at constant source power, and the discussion for the result is done there only. The results are shown in the last subsection under PV power variation by varying the solar irradiance. The output load power is kept constant at that time, and its discussion is presented for the simulation results.

Simulation and Design It included running the MATLAB program for PID controller once for control with the specified variables implemented for maximum power point tracking and inverter control in the hybrid WIND/PHOTOVOLTAIC system. Load demand is 5 kW throughout the simulation of an on-grid Photovoltaic "PV" system, except at specific times when the load demand is higher. As a result, using (42) PV modules and arranging them as follows (Ns=7 and Np =6) are considered during PV modeling, which means that the modules used from category 250 W which we have simulated, the research results are explained and a comprehensive discussion is provided.

We only considered resistive loads in this simulation work, and for change loads connected with circuit breakers, a hybrid (PV/WIND) (solar panels, wind turbines) system was built using MATLAB/SIMULINK. The system structure is shown in Figure 8 for the purpose of generating environmentally friendly electric power.

The simulation results of the entire Hybrid system are described given along with comprehensive simulation results that discover the system's feasibility, noting the system's output and examining the voltage results (Grid utility grid, wind turbine, Single phase inverter), we note its stability, and Figure 9 depicts the system's internal structure, which shows the national network linked via the hybrid system used.

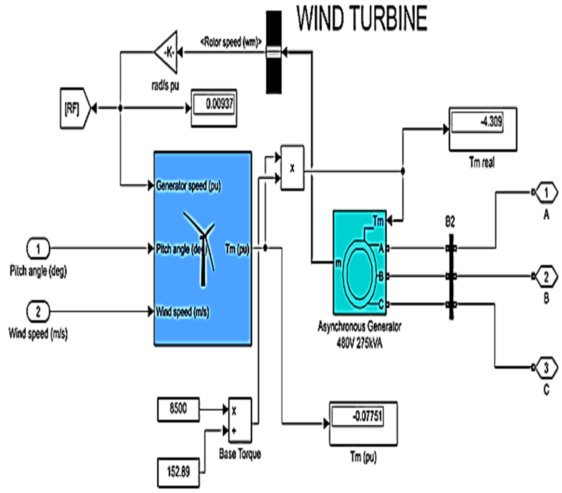


Figure 7 Wind Turbine in Mat lab

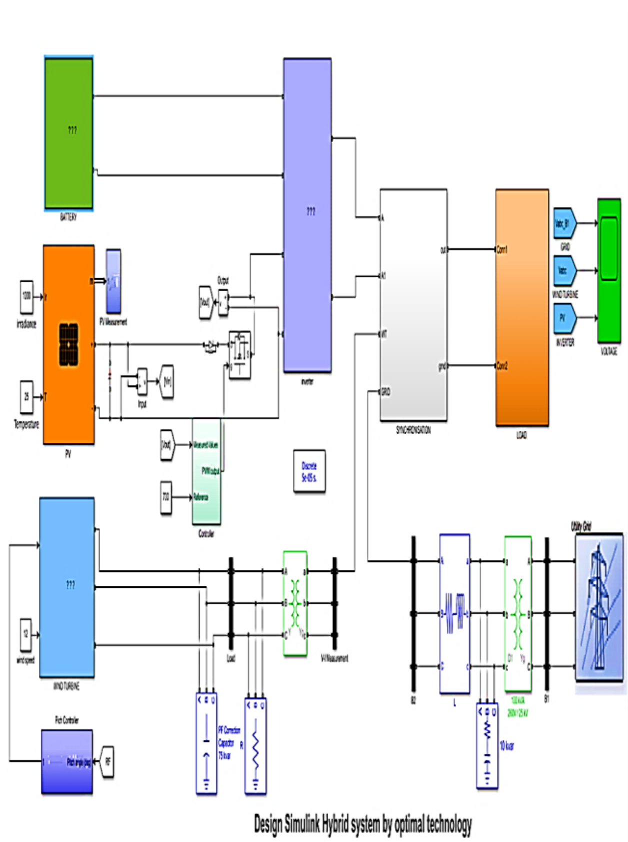


Figure 9 proposed Simulink model used for simulation.

- Study Case -- Wind speed 100 W/m2 --- Wind speed =20 W/m2

➢ Study Case -- Change Turbine Angle in Figure (10) show techniques in change shift turbine to get best results.

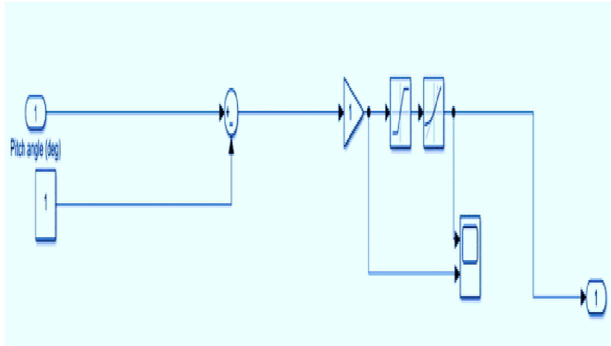


Figure 10 Change Turbine Angle

In Figure 11 show voltage output at time (0.5) from grid, wind turbine and single phase

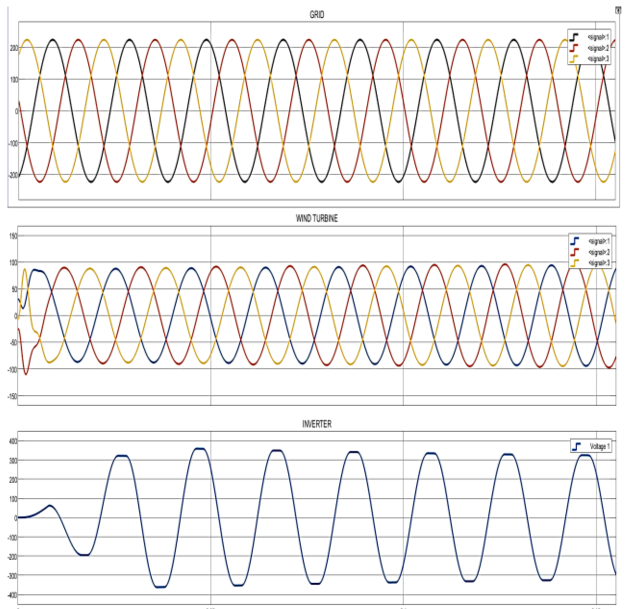


Figure 11 voltage output time (0.5)

a) Grid b) wind turbine c) Single Phase Inverter

In Figure 12 wind speed 20 m/s the output power equal 500 w and figure 13 wind speed 12 m/s the output power equal to 150 w , we note that the higher wind speed, the greate Output from the wind system.

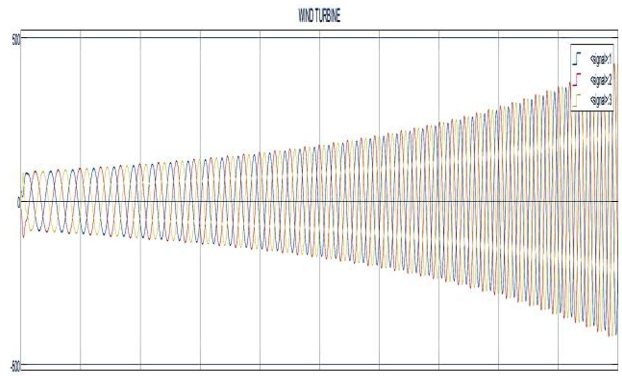


Figure 12 Output Power when Wind speed 20 m/S

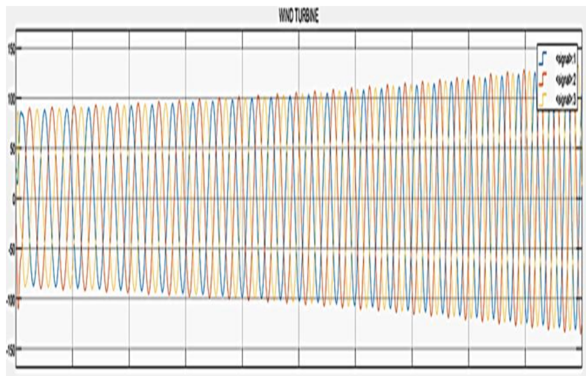


Figure 13 Output Power when Wind speed 12 m/S

4. Conclusion

In this research, different scenarios were studied according to the change in climatic conditions and note the best result in hybrid system, including the change in wind speed, and the change in the energy value was observed. The more the wind increased, the more the energy increased. The tracking method was used to extract the maximum value of the available energy.

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