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Simulation and Analysis of Composite Wind/Solar Energy Transformation System

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Abstract – Solar and wind are the most popular resources due to its ease of availability and its ease conversion into electricity. Each renewable resource require DC/DC boost converter with MPPT control for power generation. To obtain high efficiency of photovoltaic (PV) system and wind energy system, the maximum power point tracking (MPPT) technology is employed. Perturb and Observe MPPT technique is used for PV system in which dc voltage is used as perturbation variable. While in wind energy system, perturbation variable as a dc current is used in modified perturb and observe MPPT algorithm. Modified perturb and observe algorithm is stable and tracks fast for sudden wind speed change conditions. Maximum Power Point Tracking (MPPT) technique used with boost converter extracts maximum power from the source when it is available. Simulation of both the renewable energy sources is carried out separately in PSIM 9.0 with different MPPT types of techniques.

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I. INTRODUCTION

Due to the critical condition of industrial fuels which include oil, gas and others, the development of renewable energy sources is continuously improving. This is the reason why renewable energy sources have become more important these days. Few other reasons include advantages like abundant availability in nature, eco-friendly and recyclable. Many renewable energy sources like solar, wind, hydel and tidal are there. Among these renewable sources solar and wind energy are the world's fastest growing energy resources. With no emission of pollutants, energy conversion is done wind and PV cells.

Day by day, the demand for electricity is rapidly increasing. But the available base load plants are not able to supply electricity as per demand. So these energy sources can be used to bridge the gap between supply and demand during peak loads. This kind of small scale stand-alone power generating systems can also be used in remote areas where conventional power generation is impractical.

In this paper, simulation of solar energy system and wind energy system with MPPT technique is done separately. MPPT technique is employed with DC/DC converter to turn on/off the controlled switch of the boost converter. Simulation is carried out in PSIM 9.0. MPPT algorithm used for the PV system is perturb and observe algorithm which is adopted from PSIM renewable examples while MPPT algorithm for wind energy system was programmed in visual C++ from the proposed modified perturb and observe algorithm in [6]. Results are compared by changing input conditions of sources like for PV system- irradiance and for wind system- wind speed, and output is observed. With different input conditions, power generated from these sources must be equal to power delivered to the load which is shown in simulation results.

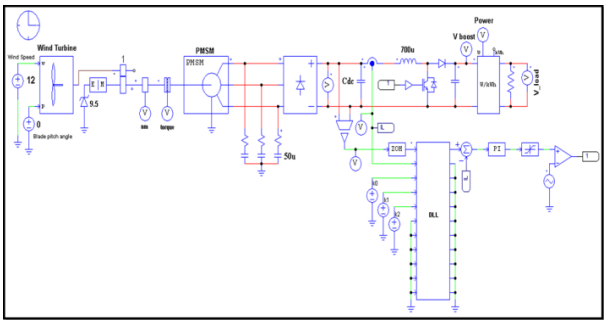

Fig. 1 Wind energy Energy

II. SIMULATION OF WIND ENERGYSYSTEM

The schematic diagram of the wind energy system to which the MPPT applied is shown in Fig.1. Generator used is of permanent magnet synchronous generator type which is directly coupled to turbine due to its advantages like no need of gear box, small size, very less maintenance cost, no requirement of excitation current[6]. Instead of using three-phase controlled rectifier, diode bridge rectifier is used which

converts the AC to a DC by rectifying voltage at constant level using boost converter.

A. MPPT tracking for varying wind speed

Fig.2 shows variation in different parameters like power, voltage and current with change in wind speed. The system starts with 8 m/s wind speed at which power starts increasing and achieves MPP and becomes constant. Also load current and load voltage starts increasing as shown in Fig.6. Then wind starts increasing and its speed becomes constant 12 m/s after some time. During this sudden change in wind speed, dc voltage increases which leads to the algorithm in prediction mode where it proceeds by increasing current with larger steps. After sometime wind speed becomes constant which leads to the algorithm into normal perturb and observe algorithm. This mode is active till wind speed starts decreasing slowly from 12 to 9 m/s. The algorithm starts decreasing the current command with steps that are scaled by the measured slope.

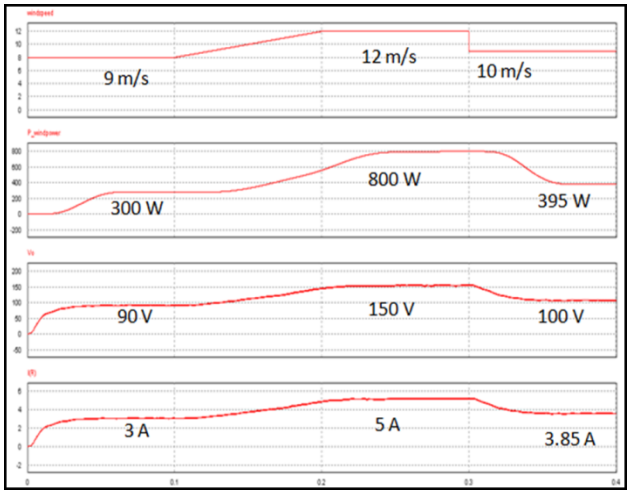

Fig.2 Variation of Different Parameters with Sudden Wind Speed Change

III. SIMULATION OF SOLAR ENERGYSYSTEM

Solar energy is a renewable energy resource which can be converted into the electrical power using PV cells. There are two factors-radiations and temperature which can affect the output of PV panels. If irradiance increases then current increases but variation in voltage is very less. If temperature increases, open circuit voltage decreases while if intensity of solar radiation increases, short circuit current increases. Thus I-V and P-V curve changes with change in temperature and irradiance, which also changes maximum power point.

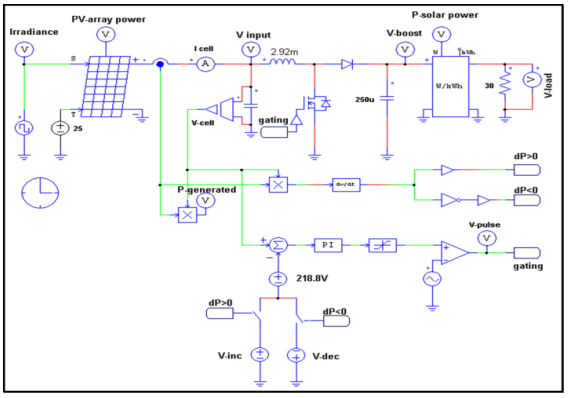

Fig.3 Solar energy system

B. MPPT tracking for different values of resistance

MPPT technique which tracks the power generated from solar panel for different resistance is shown in Fig. 4. For R=20 ohm, MPPT technique works efficiently as shown in results but for R=10 ohm MPPT tracking is inaccurate.

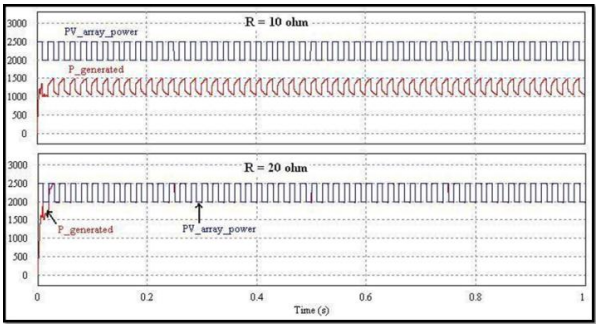

Fig. 4 MPPT tracking for 10 ohm and 20 ohm

Thus minimum value of resistance should be 20 ohm to track maximum power. For higher values of resistance i.e. more than 20 ohm MPPT tracking works efficiently. Power flowing through load with different resistance values is shown in Table II. As resistance increases power varies by small amount nearly 5-10%.

IV. SIMULATION OF HYBRID ENERGY SYSTEM

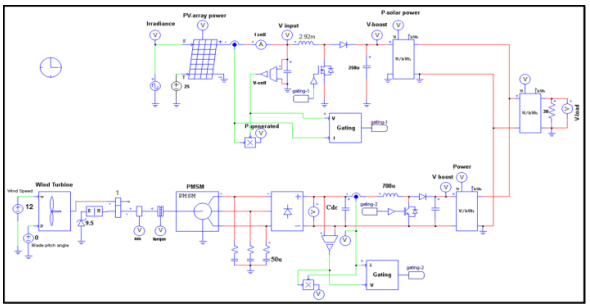

Fig.5 Solar energy system

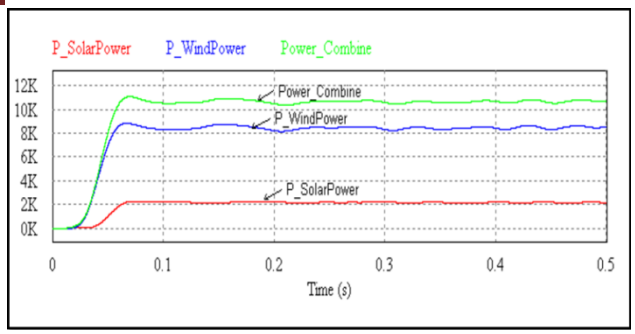

Fig.6 Power in Hybrid Energy System with constant resistance 15 Ω

V. CONCLUSIONS

The simulation of the MPPT technique achieves the maximum power point for wind energy system as well PV system. For a particular irradiance level, maximum power generated by wind generator/PV system is delivered by using MPPT technique at the load. For PV system, perturb and observe MPPT technique is used which works efficiently. For wind energy system, modified perturb and technique adopted from IEEE transactions on energy conversion [6] is used in which with normal wind speed conventional perturb and observe technique is employed and with rapidly wind speed conditions prediction mode is employed. Under rapid wind speed condition, conventional P&O has the direction misleading problems while prediction mode reaches MPP faster.

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