ABSTRACT

This thesis represents the dynamic behavior and power management of a stand-alone hybrid power generation system to extract the maximum energy obtained from a variable speed wind power generation system. The hybrid system consists of a 275 kW wind turbine which drives a 480 V, 275 kVA induction generator, a 27 kW micro-turbine driving a high-speed permanent magnet synchronous machine, solar heater cells which preheat the air entering the combustion chamber of the micro-turbine, thus decreasing the amount of fuel mass flow rate, and finally battery storage for charging and discharging electrical energy.

For meeting more load demands, the hybrid solar micro-turbine generation system and battery storage are combined with the wind turbine as a backup to satisfy the load demand under all conditions.

The mathematical model is being presented. Two supervisory controllers were designed that able to manage between the maximum energy captured from the wind turbine, the generated energy by the hybrid solar microturbine and the battery storage to meet the load demands and wind power fluctuation due to wind speed variation. The first is for the wind turbine and the hybrid solar micro-turbine. It is designed to determine the amount of power required by the hybrid solar micro-turbine. The second is for the battery storage system to adjust the modes of operation which are active by storing or supplying power and passive. MATLAB Simulink™ 7.12.0 is used to evaluate the performance of the proposed hybrid model.

Simulation was conducted for variable loads and variable wind speeds. The results showed an improvement in the performance of the micro-turbine power generation system using the PID over a nominal governor. Solar heater cells have succeeded in saving the fuel consumed in the micro-turbine through the preheating process. Also, extra wind power generated has been stored instead of wasting it using a dump variable load. Moreover, a power management control succeeded in providing the demanded load from different power sources of energy.

The average wind speed, the average solar irradiance on the tilted plane of the collector and the average environment temperature are being collected during the twelve months in El Zafarana, Red Sea, Egypt. The wind speed input, solar irradiance and environmental temperature have been changed during the simulation to study the response of the hybrid power generation model during the year, and finally a case of study was held in Zafarana providing an estimate for the maximum load could be provided during the year.