ANALYSIS ON WIND SOLAR HYBRID SYSTEM FOR STAND -ALONE POWER GENERATION IN SRI LANKA

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by

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DECLARATION

The work submitted in this dissertation is the result of my own investigation, except where otherwise stated.

It has not already been accepted for any degree, and is also not being concurrently submitted for any other degree.

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Date 10/02/2011

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Abstract

The 100W wind home power generation system fabricated and installed by the NERDC at Nikavatiya in Kurunagala district is facing insufficient power generation within few months due to monsoon wind changes. The researcher was motivated to develop a hybrid wind solar power generation system to overcome this challenge. The power consumption of a rural house was evaluated and metrological data (wind speed and solar irradiance) were measured during year 2008 as part of this study. According to the metrological data, 3.92 m/s wind speed and 5.44 kWh/m^2/day solar potential could be obtained from the site annually.

The dynamic behavior and simulation results in a stand – alone hybrid power generation system of wind turbine, solar array and battery storage are presented by this analysis. This study is to review the state of the simulation, optimization and control technologies for the stand-alone hybrid solar–wind energy systems with battery storage. The hybrid system includes a 100W wind turbine, 150W solar array, 70Ah Lead -acid battery, AC/DC rectifier and DC/AC inverter.

The NACA 4415 two bladed wind rotor performance was analyzed theoretically by using blade elementary and momentum theory and the parameters of this analysis were found by using C++ program. The performance of a Fuzzy Logic Maximum Power Point Tracker (MPPT) controller (hill climbed) was applied for variable – speed, fixed –pitch NERDC small-scale wind turbines as wind speed sensor less application. More 35 % of extra energy absorb from the system by using Fuzzy Logic controller than fixed voltage method. The maximum power point tracking (MPPT) method based on perturbation & Observation (P&O) searching algorithm was applied to stand – alone solar photovoltaic system. The P&O algorithm was tested with actual irradiance data provided by simulations, using sunny day and cloudy day two sets of irradiation data. The simulation result shows the efficiency of 96.2% for P & O algorithm. The 70Ah lead – acid batteries were used in for the analysis and the same type is used for the hybrid solar–wind power generation system. Lead – Acid battery model was developed and simulated with Simulink software platform. Also laboratory testing was done according to the SLS 1126 test procedures.

MATLAB Simulink^{TM} 7.2 / Simpower system software environment was used to simulate individual wind and PV dynamic models of hybrid system. HOMER has being used extensively to optimize the hybrid system size, sensitivity analysis with case study data in stand-alone areas in Sri Lanka. The 60 W solar PV array and NERDC 100W wind turbine with 70Ah four battery bank is proposed as hybrid power system and battery state of charge (SOC) is close to 100 % present level annually. Correct modeling of the dynamic and non linear systems is an important area of the study, but various difficulties remain in the current study. Some approaches of analysis are limited with use of commonly available simulation software.

Physical implementation of the system with power electronics remains for future research. The author suggests that solar home power system is suitable below the wind speed of 3.5 m/s , solar and wind hybrid system for the wind speed between 3.5m/s to 4.5 m/s and the wind turbine home power generation system for the wind speed above of 4.5 m/s to fulfill the rural energy requirement .

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