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Design and Optimization of Hybrid PV-Wind Renewable Energy System ^{*}

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Abstract

Hybrid renewable energy system is the combination of two or more energy sources which is used to supply the targeted load. One of the most important applications of renewable energy system is the installation of well design hybrid energy system in remote areas where grid extension is very difficult and costly. But the proper design of such system is the challenging task as the coordination between different energy sources; energy storage and load are very complicated. An optimization of hybrid renewable energy system is the process of selecting suitable components, its sizing and control strategy to provide efficient, reliable and cost effective alternative energy to the society. This paper presents the design of an optimized hybrid renewable energy system consisting of photovoltaic, wind generator with battery and converter. The system has been optimally simulated by using IHOGA (Improved Hybrid Optimization Genetic Algorithm) tool developed by the Electric engineering department of the university of Zaragoza, Spain. The paper also described the sensitivity analysis of hybrid system which help to access the effect of uncertainty or change in the variable and finding the most suitable solution for hybrid system.

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Keywords: Hybrid renewable energy system; IHOGA; Optimization; PV-wind; Simulation

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1. Introduction

Now an energy being a vital issue. No one can imagine life without electricity. The role of energy generation is one of the most important factors for the development of any country. The main sources of energy now depleting and conventional systems have failed to provide reliable electricity in rural areas or remote areas which away from the grid [1]. Hence now it is essential to look towards alternative energy sources like renewable sources PV, wind, biomass, hydro etc. But the high installation cost especially for photovoltaic made its growth slow one. Now a day due to advance material, new manufacturing process and advance technology made them a more attractive solution for the energy problem.

Hybrid energy system is the combination of two or more energy resources to supply the load. Various considerations must be taken into account while working with the hybrid energy system for electricity production. The reliability and cost are the two important aspects must be considered while designing the hybrid energy system. Many researchers worked on the design, simulation and optimization of hybrid renewable energy system.

In 2010 Ahmad Rohani, Kazem Mazlumi and Hossein kord [1] proposed a system to design the aspects of a hybrid power system. The main power of the hybrid system comes from the photovoltaic panels and wind generators, while the fuel cell and batteries are used as backup units. The optimization software used for this system is HOMER. Also N. Razak, M. Othman & I. Musirin [2] has discussed on optimization, sizing & operational strategy of HRES which refers to the minimum TNPC. They compare the two hybrid energy model, PV array, battery and converter but this system provide the electricity at night additional battery storage and converter are require this will increase the cost of TNPC on the other hand the combination of wind turbine, diesel generator, battery storage & converter brings to the TNPC value lower than earlier one. In 2011 M. Hossain, M. Maruf Hossain and A. Reazul Haque [3] proposed a small scale hybrid renewable system consist of the PV array, small hydro plant with battery and diesel generator for backup. In this paper the initial optimum planning of hybrid system can be done with the help of HOMER secondly a dynamic model has been derived with the required formulation. The authors G. Vuc, I. Borlea [4] presented the optimal mix solar wind system for grid connection and it was found that optimal mixture of wind power produces approximately 50% of total electricity and PV contributes with about 1%, so the PV share rest lower and strongly dependent on capital multiplier. Such system can permit to respect some important principles of sustainability in the energy system. Rui Huang [5] developed the PV-wind system based on empirical weather and load data. To determine the system size, they formulate an optimization problem that minimizes the total construction and operation cost subject to maximum tolerable risk by using HOMER and assuming the weather resources and load keeps unchanged.

From the literature survey cleared that the selection, sizing of individual component and control strategy play very vital role in the overall cost of the hybrid energy system. Researchers developed and used different techniques for simulation and optimization. This paper presents the simulation and optimization model of hybrid energy system using IHOGA which worked on genetic algorithm. This tool calculates the optimum system configuration and allows the designer to evaluate economic and technical feasibility of a large number of technologies. The main aim to minimize the total net present cost of the system.

Nomenclature

T	Temperature (K)	G	Solar irradiance
Npanels_series	Number of panels in series	LF	Loss factor
Npanels_parallel	Number of panels in parallel	P	Pressure (Pa)
R	Ideal gas constant, 8,31432(J/mol·K)	ρ	Density (kg/m ³)
H	Height above sea level (m)	Tc	Internal cell temperature
Po	Standard pressure at sea level, 101325 (Pa)	G	9,80665 (m/s ²)
To	Standard temperature at sea level, 288,15 (K)	Ct	Temperature coefficient
L	The variation rate of temperature vs. height 0,0065 (K/m)		
M	Molecular weight of dry air, 289644(g/mol)		
Isc	Short circuit current of PV panel		

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