Abstract

The great availability of renewable energy resources such as wind and solar has triggered a revolution of green energy in the 21st century that led to the development of hybrid energy supplies. Many research works have dealt with optimizing hybrid energy supplies but majority of them failed to optimize the cost of supply from the perspective of the consumer. This consists of a drawback to many optimization approaches which this paper aims at solving. The objective of the paper is therefore to optimize the cost of energy from consumer perspective by adopting the best combination of initial renewable energy plants that supply a required load for a given time. An analytical model of solar plant, wind plant and hydropower plant were first proposed and later combined with cost criteria to create an objective function. The optimization problem was put in a linear form with inequality constraints and was solved by computational methods involving the special function linprog of Matlab. Data were collected on three specific locations in Ghana including Navrongo, Kumasi and Accra and fed into the program. Results show that the hybrid system dynamism is very consistent and reliable in the sense that it gives priority to the hydro followed by the wind and finally by the solar, owing to the fact that the hydro cost is lower than the wind cost and the wind energy cost is also lower than the solar one. An
average cost of hybrid electricity was further determined for the three sites tested, and the values were 0.465$/kWh, 0.458$/kWh and 0.451$/kWh respectively for Navrongo, Kumasi and Accra. It was also shown that the unit cost of electricity for solar, wind and hydro power plants were estimated to 0.685$/kWh, 0.515$/kWh, 0.388$/kWh respectively. This show in all cases that, the hybrid system yielded a good cost estimate that minimizes the consumer’s bill.

References


Index Terms
Cost Optimization of an Electrical Energy Supply from a Hybrid Solar, Wind and Hydropower Plant

Keywords
Solar Energy  Wind Energy  Hydro Energy  Cost optimization  Matlab Simulation