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Study on optimization techniques for PV-Wind based hybrid renewable energy system

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Abstract
Renewable Energy is the energy which occurs from the resources that are regenerative. Renewable energy is moreover called the alternative energy to conventional energy. The prime sources of renewable energy are sunlight and wind. The individual utilization of solar and wind power may have the issues like over-sizing and increases the implementation cost. It is found that the use of one of the optimization sizing techniques could help to guarantee the maximum power reliability and the minimum system cost for the future hybrid implementation. The theme of the paper is to find the optimization techniques of hybrid PV-wind based system and presented three optimization techniques including the hybrid systems.

Keywords: hybrid renewable energy, optimization techniques, non-conventional energy, solar energy, wind energy

1. Introduction

Now-a-days the renewable energy is placing a key role for producing the power. For the past ten years PV-sources have more growth compared with the other. Solar Energy is the energy which occurs from the sun. Solar energy is a renewable energy. This energy, we can abstract from the sun and we can store it in the battery. This battery can help us to use the power in the irrespective cases of power. We can extract a large amount of power from solar radiations. Solar energy is an alternative use of energy. Wind energy is also called as kinetic energy which occurs by the movement of the atmospheric air. Wind energy systems can covert kinetic energy in different forms of power. Wind turbines are one of the source which can generate the power. The wind energy coverts the wind to mechanical power. Hybrid power system means the combining sources of renewable energy like wind generators, solar batteries etc.

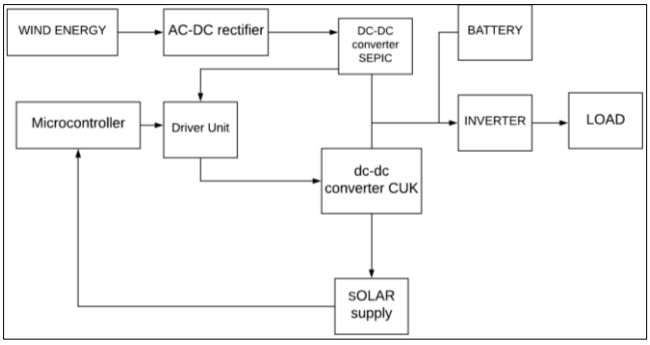

Fig 1: Solar-Wind hybrid system

Figure 1 shows the hybrid PV system block diagram. The wind mill generated the power. The generated power is in the form of AC voltage. This AC is converted into DC rectifier.
A voltage converter is used to step up or down the voltage by the switch called "SERIC". For regulation purpose the CUK converter is used. Thecontroller which is used in this system is micro controller. The micro controller frequently refers the operation of sources and it is converted in to battery or inverter. The result of the inverter is connected to the load and then the voltage is stepped up by the transformer. For the MOSFET converters the gate signal is given by the driver circuit.

2. Optimization techniques and algorithms

a) *Iterative Technique*

The Iterative method is a calculated method that gives an approximate solution for the problems. This process continuous until the finestformation is reached. Iterative technique is used for designing and optimizing the hybrid renewable energy. Yang *et al.* [1], proposed hybrid solar wind system optimization model by using this technique. Kellogg *et al.* [2], used this technique to the enhancethe PV modules and Wind turbines. Using lowest level of cost of energy. Diaf *et al.* [3], performed optimal sizing of hybrid PV wind system.
The optimum size of solar panels and wind turbines and capacity of batteries of the hybrid based system based on deficiency of life cycle cost, levilized energy cost and life cycle cost, levilized energy cost and life cycle unit cost of power generation with atterybbank are determined by Prasad and Niranjan *et al.* [4].
The optimal range of battery bank and PV range for a stand-alone hybrid wind-PV system and concluded the preferred reliability of the hybrid system. An optimal combination like PV and wind machinery which gives the system dependability and less number of existence sequence cost which can be useful in rural villages in the form of renewable power generation are proposed by Ashok *et al.* [5].
This technique requires more computational solutions and it has two main parameters. They are: PV module angle and wind turbine. The Process that how this technique works is shown in figure 2.

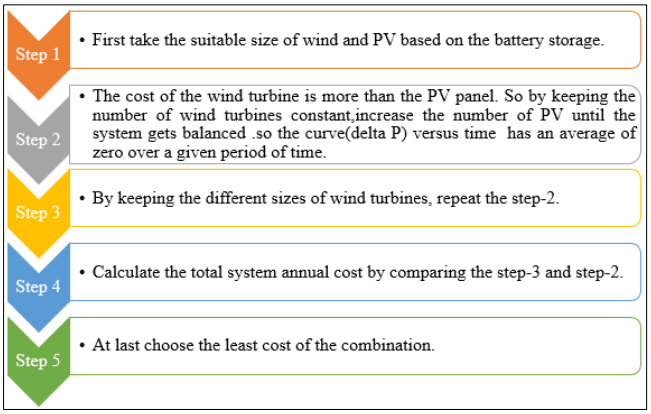

Fig 2: Process involved in Iterative Technique

b) *Linear Programming Technique*

Linear programming method was first introduced by Kantorovich in 1939. This technique is used to determine sizing and optimization of renewable energy systems. By using this technique Chedid and Rehman *et al.* [6] proposed a best design for solar- wind hybrid system to minimize the cost of electricity while reaching the needs of loads in a correct manner along with the environmental factors. Huneke *et al.* [7] by using this linear programming, they obtained the optimal configuration for a solar-wind-battery-diesel base power generator which is used to combine the off-grid energy systems. This technique has two main advantages. They are: less cost and more dependability. By using this technique sizing and simulation of hybrid system by Nogueira *et al.* [8]. The various power losses of hybrid power systems are explained by Lee *et al.* [9]. They focused on the increasing of outsourced electricity supply but not on the decreasing of total cost. Saif *et al.* [10] explained this technique by taking two objectives: They are minimizing total cost and reducing the whole cost and decreasing the total carbon dioxide emissions. The component sizes which are used in PV-wind energy system are explained by Nagabhushana *et al.* [11].

Among the above techniques, linear programming technique is the best one because it improves the quality of decision and it is more flexible than the other techniques and many number of harms can be easily solved.

c) *Artificial Intelligence Technique*

Artificial intelligence technique does not need the availability of weather data for sizing of integrated energy systems in remote areas. Some algorithms like genetic algorithm, harmony search algorithm etc. and can hold the non-linear deviation of the system components of renewable energy system. According to Sunanda. *et al.* [12], this technique was used at last 10 years and can have better accuracy. Adding of two algorithms can give better result compared with single algorithm. The bond between the amount of storage units and the number of cycles are explained by Paliwal *et al.* [13]. Mereiatel *et al.* [14] carried out analysis for an optimal solution in PV-wind diesel based hybrid system with the combinations of three battery technologies. They are lead acid, lithium ion, vanadium redon flow battery.

d) *Particle Swarm Optimization Algorithm*

Particle Swarm Optimization was first introduced by Kennedy and Eberhard *et al.* [15]. This algorithm is used to determine the optimization of the wind-solar-battery-super capacitor based on renewable hybrid system. The main objective of this technique is to reduce one-time investments and operation costs. Particle Swarm Optimization algorithm gives better and faster results comparable to traditional Swarm Optimization. There are many advantages. They are: The researching speed is very fast; calculation is very simple compared to the other algorithms. There are some limitations in this algorithm. They are: It cannot do the problems of non-coordinate system. It easily effected by the partial optimism. Basir and Sadeh *et al.* [16], combined the wind, photovoltaic and tidal energy to determine the capacity of hybrid system. An equal loss factor was utilized as an index to estimate the system dependability level. Lee and Chen *et al.* [17] used an evolutionary particle swarm algorithm to solve wind-photovoltaic capacity coordination by maximize the gain-cost ratio. The aim of this is to the hybrid system annual cost to reach the load demand. By using this advanced particle swarm optimization algorithm, the faults which occurs in

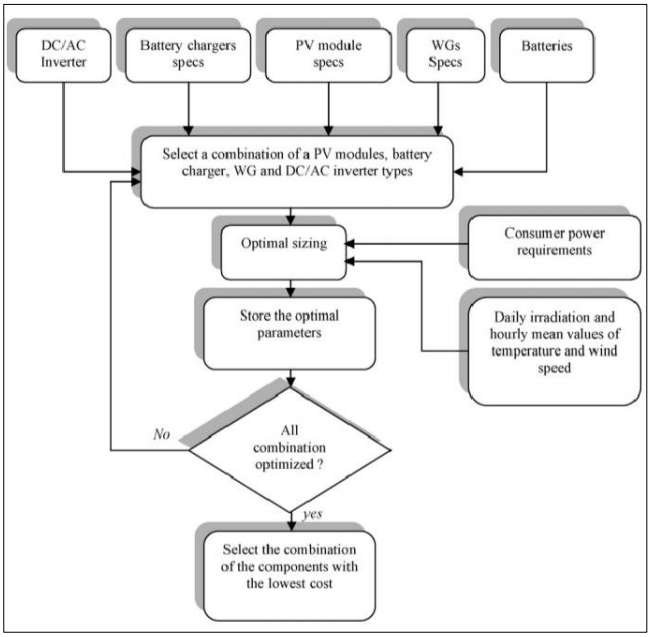

Fig 3: Particle Swarm Optimization Algorithm

local can be minimized. Thus, we can say that it is an effective algorithm. Borhanazed *et al.* [18], used multi-objective particle swarm optimization to obtain the best configuration of the PV-wind-diesel-battery based hybrid systems. The optimal size of hybrid PV systems are carried out by Malaki *et al.* [19] in some remote areas.

2.1 *Genetic Algorithm*

In the period of 1960-1970, John Holland *et al.* [20], developed an algorithm named as genetic algorithm that resembles the method of natural collection. Using the methods inspired by natural development such as inheritance, mutation, selection and crossover, the genetic algorithm generates solutions to the optimization problems. The advantages of genetic algorithm are: Problem solving with many solutions, simple to understand and can be easily transferred to presented simulation and model etc. Genetic algorithm has some disadvantages. They did not conserve the constant optimization response, and cannot assure

the arbitrary points then the global optimum. etc. This algorithm is used by many number of researchers for the best design and function of hybrid PV system.

Koutroulis *et al*. [21], proposed an optimal sizing of standalone PV-wind systems using genetic algorithm to select the optimal number of units with less cost subject to load demand fulfillment. In another study, he presented a genetic algorithm based on optimal sizing of desalination systems by PV-wind generators as a power supplied unit. Another genetic algorithm to optimize the configurations of hybrid solar-wind-battery bank system was proposed by Yang *et al*. [22]. In this configuration, the photovoltaic slope angle and the tower height are determined. This algorithm explains that how the power supply to the telecommunication station. This algorithm satisfies two main principles they are cost minimization and reducing the power supply loss and probability, Bilal *et al*. [23], explained on the sizing of solar-wind-battery to the genetic algorithm. To give up optimum PV wind and battery ratings with less cost and power reliability, Nafeh *et al*. [24] proposed a genetic algorithm. The process of optimum sizing of a PV-wind-diesel battery was proposed by Abdullrahman and Addoweesh *et al*. [25]. Hybrid genetic algorithm was proposed by Atia and Yamada *et al*. A genetic algorithm to optimize hybrid system with three different battery technologies was given by Merei *et al*. [26]. Table 1 gives the analysis of optimization techniques and algorithms.

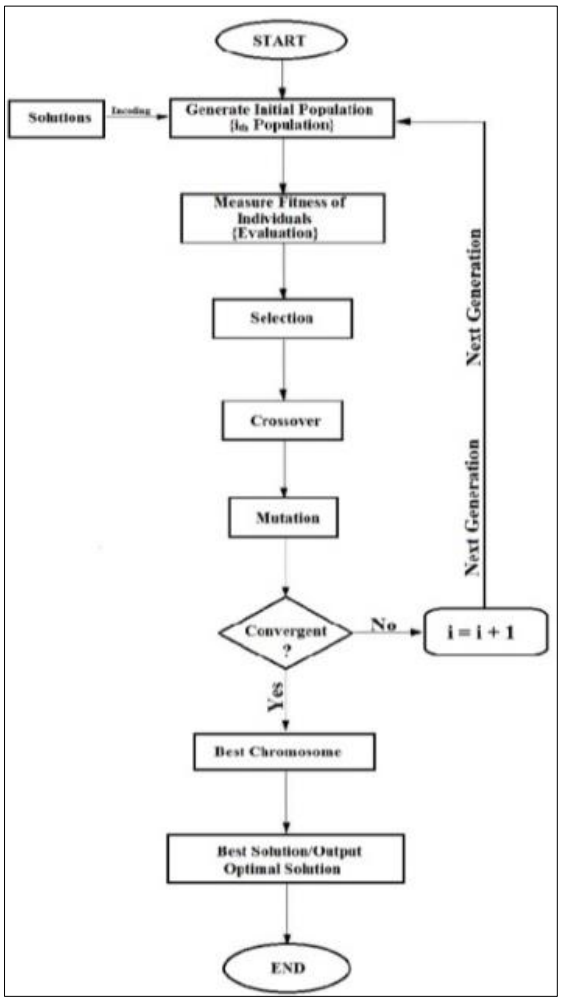

Fig 4: Genetic Algorithm

Table 1: Analysis of optimization techniques and algorithms

Technique	*Description*
Genetic Algorithm	Can solve the problems in many ways with multiple solutions. In the simulations can also be takes place. For simulation purpose "MATLAB" is used.
Particle Swarm Optimization Algorithm	In this, calculation is very simple, easily getting of solutions and it cannot workout for non-coordinate system.
Iterative Technique	It is easy to understand. It is a recursive process. It will stop when the best configuration is reached.
Linear Programming Technique	It is based on the mathematical models. It is used to solve complex problems and it is very easy to use.
Artificial Intelligence Technique	It does not need the weather data. It requires less computation time.

3. Conclusion

This paper presents the optimization techniques involved in hybrid PV-wind based hybrid system. The techniques and algorithms which are presented in this paper show the development of this hybrid PV-wind system. By comparing with last decades, the present trend is looking about the renewable energy sources i.e., wind, light etc. The combining of two techniques or algorithms can give the better output than the single one. For the future generation, the research on hybrid PV-wind based system is needed.

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