A Review on Renewable Energy Sources for Hybrid Power Generation

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***Abstract*— Electricity being an imperative section of recent age technology for relentless development. The electrical energy consumption is expanding all over the terra due to which the gap between the demand of electrical power and generation is increasing. Raising cost of the fossil fuel has led the accentuation on the application of renewable energy sources as an alternative source of power generation. The assorted execution of solar and wind energy sources are in demand for power generation, as they also smite the problems such as unavailability either of solar or wind power throughout the year due to their unpredictive nature by using hybrid renewable energy instead of considering any single source (solar or wind or biomass) become cost effective by minimizing unit cost of generation.**

The main objective of this paper is to represent neuter outlook by variant authors in context of optimize stand-alone solar-wind hybrid power generation system and maximize the use of renewable energy resources while minimizing the total tariff of system. The HOMER optimized the system in constrained of various costs of system, percentage of renewable energy uses, carbon emission, and electrical load requirement throughout the year.

Index Terms— Hybrid Optimization Model for Electric Renewables (HOMER), Hybrid Renewable Energy System (HRES), Renewable Energy (RE), Renewable Energy System (RES).

I. INTRODUCTION

The most crucial commodity of this modern day is the Electrical Power. Electricity is identified as a vital role to initiate a process of development and to maintain a continuous development for a small community to a country. With extended industrialization, eviscration in fossil fuel option for the source of power is renewable energy. However, all renewable energy sources have drawbacks. Due to the dependence on variable sunshine hours and changing wind speeds, these resources do not out-turn productive energy continuously throughout the year. But the implementation of two or more energy resources can circumvent these problems. The hybrid renewable energy systems (HRES) can be installed to produce considerable amount of energy in areas which are suffering from huge electricity cuts or the remote areas which are still unelectrified. Solar energy and wind energy have been deemed clean, inexhaustible, unlimited, and environmental friendly. Such characteristics have attracted the energy sector to use renewable energy sources on a larger scale. The environmental benefit of renewable systems is widely accepted and thus if proved to be economically beneficial as well, it will give the government and organizations an incentive to implement such system in suitable locations. However our present government under Prime Minister Narendra Modi is very much focusing on renewable energy sources for power generation.

A. Wind Power

Wind energy technologies use the energy in wind for practical purposes such as generating electricity, charging batteries, pumping water, and grinding grain. Wind is a natural phenomenon related to the movement of air masses caused primarily by the differential solar heating of the earth's surface. Seasonal variations in the energy received from the sun affect the strength and direction of the wind. The wind turbine captures the winds kinetic energy in a rotor consisting of two or more blades mechanically coupled to an electrical generator. The turbine is mounted on a tall tower to enhance the energy capture.

B. Solar Power

India is densely populated and has high solar insolation, an ideal combination for using solar power in India. The solar modules (photovoltaic cell) generate DC electricity whenever sunlight falls in solar cells. The solar modules should be tilted at an optimum angle for that particular location, face due south, and should not be shaded at any time of the day.

C. *Hybrid Solar Wind System*

A stand-alone wind system with solar photovoltaic system is the best hybrid combination of all renewable energy systems and is suitable for most of the applications, taking care of seasonal changes. They also complement each other during lean periods, for example, additional energy production through wind during monsoon months compensate the less output generated by solar. Similarly, during winter when the wind is dull, solar photovoltaic takes over. The hybrid solar wind power system is as shown in figure 1.

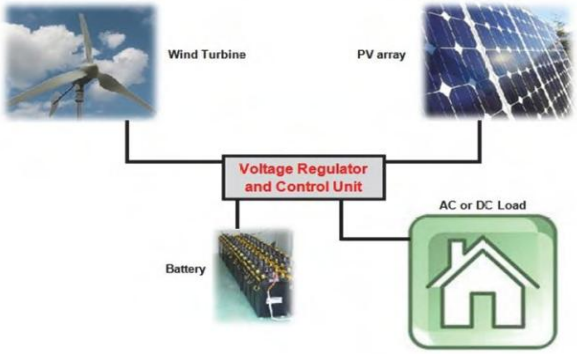

Fig 1: Hybrid Solar Wind Power System

II. LITERATURE REVIEW

[Parita Dalwadi, et-al, 2011] demonstrated a wind-solar hybrid system as an alternative energy source for location at Vadodara, where hybrid system produced electricity 61% from PV cell and rest 39% from wind energy. Solar power or wind power alone could fluctuate, when used together they provide a reliable source of energy. The perfect solution was to combine these two forms of energy sources to create a constant energy flow. Wind and solar sources dependent on unpredictable factors such as weather and climatic conditions. Hybrid energy stations have proven to be advantageous for decreasing the depletion rate of fossil fuels, as well as supplying energy to remote rural areas, without harming the environment. Distributed Generation includes small, modular technologies for electricity generation, located close to the load. DG technologies were used both in stand-alone mode as well as in grid parallel mode. Conventional electricity generating stations were typically located close to the fuel source and away from the loads, and electricity generated was conveyed through the transmission system to the load centre, which often requires large investment. Transmission and distribution costs account for about 30 percent of the cost of delivered electricity. DG technologies obviate the need for an expensive transmission system and minimize transmission and distribution losses.

[N. I. Maheshwari, et-al, 2012] have studied calculation of load, simulation of electrical power and its cost effectiveness with conventional system for location at an educational centre situated at Salem, India which is surrounded by Eastern Ghats. The hybrid solar-wind energy was optimized using genetic algorithm. The photovoltaic radiation was to be sensed with the help of pyrometer and the oblique angle is to be varied hence the solar energy can be optimized. Similarly, by sensing wind velocity with the help of anemometer, pitching and yawing control of the wind blades were oriented and hence the wind energy could be optimized. The back-up power was fed from storage-batteries. Assuming only the lighting load (Light+Fan+others) was supported by the off-grid wind solar hybrid power generation. The annual electricity consumption and hence the annual production should be 36 kW. The production cost estimated with respect to the present-day system for solar power was about Rs. 100,000/kW, the investment of wind solar hybrid power generation system was about 2/3 of the price above. The sustainable solar-wind energy system can be simulated using the improved genetic algorithm and actual cost effective measures were to be compared with the increasing conventional power tariff.

[Xin Chang, et-al, 2015] have analyzed the Correlation between wind power and solar power. Least squares method is used to calculate marginal probability density of wind speed Mean and variance estimation method is employed to obtain sunshine. Copula function is applied to calculate the joint probability density of wind power and solar power. The uncertainty of wind speed and sun intensity make wind and photovoltaic power generation with the randomness in a large extent, it cause a challenges for safe and economic operation of wind and solar hybrid power generation system. So that correlation of wind and solar power generation system should be analyzed to ensure economic security configuration of wind solar hybrid power generation system. Genetic algorithm had some advantage to solute the optimization problem of nonlinear or more models of complex systems. So, genetic algorithm was used to optimize the objective function of wind solar hybrid power generation system in this paper. The designed wind solar hybrid power generation system was planned to install at Keshiketeng region of Inner Mongolia of China. Environment condition was extreme bad in January during twelve months of the year at install location of optimal configuration of wind solar hybrid power generation system. If optimal system configuration could meet the relevant requirements of power supply in extreme month, then in power supply can also satisfy load requirement in another month. Thus, the data of January is used to make optimal configuration of wind solar hybrid power generation system. The rated capacity of E48 is 500-800kW for tower height 50m and its lifetime is about 25 years with 15 years operation and maintenance warranty reducing risk during the wind turbine operation.

[Kamal Joshi, et-al, 2016] suggested an optimized hybrid energy system comprising solar and wind energy resources, and battery as a backup source. The sensitivity analysis was also integrated with the feasibility and economic analysis of the system. After compared of hybrid energy system with traditional diesel generator system the amount of CO2 emitted by the traditional diesel system is 1,26,973kg/yr, which reduces significantly to 13,930kg/yr by using the proposed hybrid system. The results shown that the combination of solar and wind energy resources with battery as a backup source

brings to the optimal configuration of hybrid renewable energy system with 5% of surplus energy and could be used as off-grid system in Pithoragarh, Uttarakhand. The solar and wind energy sources served 87.92% of total energy to the load and this reduced the CO2 emissions by 89.03%. The hybrid system also results in fuel saving of 42,928litres of diesel per year compared to traditional diesel only systems.

[K. Nagasujatha, et-al, 2015] presented the optimum design of hybrid renewable system with battery backup. For this hybrid system, the meteorological data of Solar Radiation, hourly wind speed for the Department of Electrical and Electronics Engineering, Jawaharlal Nehru Technological University Hyderabad, Jagityal (Latitude18026' N, longitude is 7907'E) were taken to meet the primary load of 100Kwh/day, 28Kw peak load. Two wind turbines of Generic model of rating 10 Kw are considered in the proposed system. The capital cost, replacement and maintenance cost were estimated as $30000, $25000 and $500 respectively. Wind speed varies seasonally and average wind speed of the respective area was taken as 3.49 m/s. The installation cost of 1 kW solar energy system, and replacement costs were taken approximately as $7000 and $6000, respectively. In this study, monthly average global radiation data had been taken from NASA (National Aeronautics and Space Administration). The proposed system was designed by specified wind turbine, PV array, diesel generator, power converter and Trojan L16P battery with nominal rating 6V, 360 AH, 2.16Kwh as inputs and simulated for various cases to test the feasibility of the system and to provide best optimal and economical solution to meet the load demand. It is designed and analysed using HOMER Software for various conditions. Performance of each component had been evaluated and finally sensitivity analysis had been performed to optimize the system at different conditions. The price of fossil fuel increases with the distance of the location, hybrid energy systems could be an appropriate technology to reduced fuel consumption and environmental hazards such as the emission of CO2, CO, SO2 and NOX to the atmosphere.

[Radharaman Shaha, et-al, 2017] This paper brought a novel approach towards the optimization of various renewable energy sources to form a cost effective hybrid renewable energy source. Due to the stochastic behavior of all the RE sources, the major aspect in the design of the HRES are the reliable power supply of the consumer under varying atmospheric condition and the per unit cost of generation. The paper compared the results obtained from MATLAB simulation by considered individually the RES and then combination of the sources (HRES). MATLAB Simulation was done by considering the various parameters such as capital cost, O&M Expenses, CUF etc. and per unit cost of generation is calculated for a period of 25 years. The simulation results show that cost of generation of the electricity from the various sources shows a peak region till the breakeven point and once the payback period is reached, the cost of generation is only dependent on the Operation and Maintenance expenses of the project.

[Norat Mal Swarnkar, et-al, 2016] presented optimization of hybrid energy system for electrification at location of Rajasthan Technical University campus, Kota, Rajasthan, India. The cost of energy with grid connective system was about 4.45 INR/kWh which was suitable for application with reduction in emission due to less utilization of grid energy supply. Without grid application cost of energy was 21.68 INR/kWh which was much high for a feasible solution. The renewable energy penetration was higher in case of without grid connective system so that a reduction in the cost of storage system may increase the feasibility of hybrid energy system. The solar PV wind turbine diesel generator with battery as storage might be economical solution for supply electrical demand for remote islands and isolated village or small community applications.

[Ahmed Belhamadia, et-al, 2013] have represented comparison between five different cities in term of wind and solar energy potentials. There are several renewable energy sources (RES) introduced but the wind turbine systems and the photovoltaic (PV) systems are found to be the fast growing in technologies. By 2011, 237 GW of wind turbines had been installed, while PV systems had contributed to generate 69 GW worldwide. Malaysia has a humble average wind speed and it varies between the two different monsoons. On the other hand the annual average daily solar radiation is in the range from 4.21 kWh /m2 to 5.56 kWh /m2. All of the required data are obtained from the Malaysian Meteorological Department from 2011 to 2012. The wind speed over Mersing in general is the highest among the others, maximum wind speed is of 3.97 m/s and occurs in January, and then it drops to a minimum of 2.174 m/s in May. Since Malaysia is located in the second largest solar radiation region, there is an enormous PV energy potential. Solar radiation on the other hand is generally good over Malaysia. Kuala Terengganu receives the highest solar radiation of 5.41 kw/m2/d. Conversely, Mersing receives the lowest radiation and it was found to be 4.54 kw/m2/d. A 300W solar module would produce about 492 kW annually in Kuala Teengganu and that shown the tremendous amount of the available solar energy.

III. SOFTWARE DESCRIPTION

The HOMER is micro power optimization software developed by Mistaya Engineering, Canada for the National Renewable Energy Laboratory (NREL) USA, which can be used for design, model and analysis to determine the optimal architecture, structure, size and control strategy of the HPS. It can perform comparative economic and modeling analysis on a distributed generation power system in order to get the best solution in terms of cost, performances, size and structure.

HOMER performs the energy balance calculations for every configured system.

- For each hour it calculates the flows of energy to and from each component of the system.
- Then it determines feasibility of the configuration i.e., whether it can meet the electric demand under the specified conditions or not.

- It estimates the cost of installing and operating the system over the lifetime of the project.

For systems that include batteries or fuel-powered generators, HOMER also decides for each hour how to operate the generators and whether to charge or discharge the batteries.

IV. CONCLUSION

The survey and installation work done at distinct locations of different country resulted in great future of hybrid energy because of abundant renewable energy source. The optimization of wind solar hybrid power generation system has been studied in this review paper. Correlation between wind speed and solar has been analyzed. In these sources wind and solar energy is attracting more and more attention. Because wind solar hybrid power generation system combines the advantages of both wind power and solar power, overcoming the drawbacks of separate power supply. Hybrid systems are one of the most promising applications of renewable energy technologies in remote areas, where the cost of grid extension is high. Invention and development of wind solar hybrid power generation system is a positive attempt to replace fossil energy. Thereby, avoiding the environmental problems caused by burning of fossil. The overall cost of hybrid energy system may go down further with reduced cost of components, suitable R&D and government subsidies. India is very much enriched by all forms of renewable resources hence there is a lots of scope of power generation by renewable sources on the basis of resource feasibility and climate conditions.

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BIOGRAPHIES

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