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Cost Analysis of Hybrid System Using Homer –A Review

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ABSTRACT: This work gives a review of Homer optimization used for the analysis of cost and optimum size of a hybrid system. In the remote areas where the availability of electrical supply does not continue or supply is available for some hour, installation of the hybrid system is very economical and also pollution free system. Since the demand of power is more than the generation so there should be some new system which could be the substitute of the conventional generation system. The Hybrid system is very much useful in rural areas where the availability of electrical power is for few hours.

KEY WORDS: Hybrid Energy System, HOMER, Wind, Solar, Converter and Generator system.

I. INTRODUCTION

Solar–wind hybrid energy systems allow improving the system efficiency, power reliability and reduce the energy storage requirements for stand-alone applications. Good compensation characters are usually found between solar energy and wind energy. These hybrid systems are now becoming popular in the urban area for power generation applications due to advancements in renewable energy technologies and substantial rise in prices of petroleum products. This study recommends an optimal design model for hybrid solar–wind systems employing battery bank for calculating the system optimum configurations and ensuring that the annualized cost of the systems is minimized while satisfying the custom requirements.

The main benefit of the solar-wind hybrid system is that when solar and wind powers are used together, the reliability of the system is enhanced. These alternatives may include hybrid power systems like wind-PV, wind-diesel, PV-diesel and others with or without battery backup option. With continuous research and development efforts, it has been established that the hybrid systems, if optimized properly, are both cost effective and reliable compared to single power source systems. Additionally, the size of battery storage can be reduced as there is less dependence on only one source of power generation. Often, when there is no sun, there is plenty of the wind in India (as in Monsoon season). Winds are usually relatively strong in winter and solar radiations have the higher intensity in summer.

To get the continuous power from the renewable energy sources hybrid system installation is increasing day by day, which can provide the reliable power. A Lot of researchers has suggested different ways of optimization of a hybrid system, interfacing of hybrid system with grid etc. Here the brief note of the work which has been already done in the subject area is presented.

M. A. Motin et al. [1] Proposed that energy efficient renewable energy based Base System for an isolated location, such as Saint Martin's Island, has been proposed. Saint Martin's island is one of the most beautiful tourist islands in Bangladesh where grid connected electric system for the residents and for the telecommunication system will not be Possible to launch even in future. The residential consumers use diesel, kerosene and wood for fulfilling their energy demand. Solar and Wind resources are the hybrid options for the Island.

Mohamed El Badawe et al. [2] suggest that Telecommunication towers located in remote locations are generally powered using diesel generators and batteries. However, diesel generators require higher maintenance cost and for remote sites this cost will be more due to the added oil transportation cost. Maximizing the use of renewable energy is beneficial in reducing the diesel generation cost.

J. K. Maherchandani et al. [3] discussed that the economic feasibility of stand-alone hybrid power system consisting of Biomass/PV/Wind generators for electrical requirements of the remote locations. It emphasizes the use of renewable hybrid power system to obtain a reliable autonomous system with the optimization of the components size and the improvement of the capital cost. The main source of power to the energy system is biomass generator, whereas, photovoltaic panels and wind generators are the supported additional sources. The batteries are used to store extra energy generated that can further be used for the backup..

S. M. Hakimi et al. [4] Focused the, a novel intelligent method is applied to the problem of sizing in a hybrid power system such that the demand of residential area is met. This study is performed for Kahnouj area in south-east Iran. It is to mention that there are many similar regions around the world with this typical situation that can be expanded. The system consist of fuel cells, some wind units, some electrolyses, a reformer, an anaerobic reactor, and some hydrogen tanks. The system is assumed to be stand-alone and uses the biomass as an available energy resource.

Pragya Nema et al. [5] proposed the design idea of optimized PV-Solar and Wind Hybrid Energy System for GSM/CDMA type mobile base station over conventional diesel generator for a particular site in central India (Bhopal). For this hybrid system ,the meteorological data of Solar Insulation, hourly wind speed, are taken for Bhopal-Central India (Longitude 77o.23'and Latitude 23o.21') and the pattern of load consumption of mobile base station are studied and suitably modeled for optimization of the hybrid energy system using HOMER software.

PrabodhBajpai et al.[6] described that Decentralized distributed generation technologies based on renewable energy recourses such as Solar Photovoltaic (SPV)/ Wind Turbine Generators (WTG) address the major issues concerned with conventional diesel generators to a large extent and are therefore considered as emerging alternate power solutions to stand alone applications.

Jose´ L. Bernal-Agustı´n et al.[7] focused that Stand-alone hybrid renewable energy systems usually incur lower costs and demonstrate higher reliability than photovoltaic (PV) or wind systems. The most usual systems are PV–Wind–Battery and PV–Diesel–Battery. Usually the Energy storage is in batteries (normally of the lead-acid type).
Deepak Kumar Lal et al. [8] discussed a large proportion of the world's population lives in remote rural areas that are geographically isolated and sparsely populated. This paper proposed a hybrid power generation system suitable for remote area application. The concept of hybridizing renewable energy sources is that the base load is to be covered by largest and firmly available renewable source(s) and other intermittent source(s) should augment the base load to cover the peak load of an isolated mini electric grid system.
GM Shafiullah et al. [9] suggested current power systems create environmental impacts due to utilization of fossil fuels, especially coal, as carbon dioxide is emitted into the atmosphere. In contrast to fossil fuels, renewable energy offers alternative sources of energy which are in general pollution free, technologically effective and environmentally sustainable. At present there is an amplified interest in renewable energy, particularly solar and wind energy, which provides electricity without giving rise to carbon dioxide emissions.
S. Rehman, A. M. Mahbub et al.[10] proposed that A wind-pv-diesel hybrid power system has been designed from a village in Saudi Arabia which is presently powered by a diesel power plant consisting of eight diesel generating sets of 1,120kW each.

II. HYBRID SYSTEM

The hybrid energy system proposed consists of wind, solar power as depicted in Fig. 1. The energy system consists of a wind turbine generator, diesel generator, solar PV array, battery bank, grid power and an AC/DC converter.

Distributed electricity generation from Renewable Energy Sources (RES) such as solar and wind are increasingly seen as cost effective alternatives to centralized carbon-based generation. A disadvantage, common to wind and solar

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options, however, is their unpredictable nature and dependence on weather and climatic changes. The hybrid systems that combine solar and wind generating units with battery backup can attenuate their individual fluctuations and reduce energy storage requirements significantly.

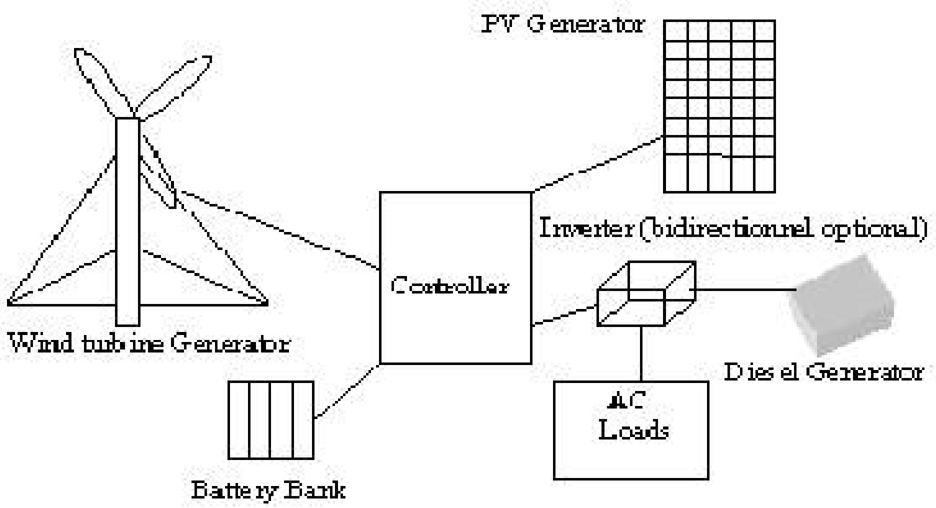

Figure 1: Schematic diagram of hybrid energy system.

III. APPROPRIATE HYBRID SYSTEM

Homer simulates the operation of a system by making energy balance calculations for each of the 8,760 hours in a year. For each hour, Homer compares the electric demand in the hour to the energy that the system can supply in that hour, and calculates the flows of energy to and from each component of the system. All the resources and inputs simulated and we got the 360 sustainable configurations. This simulation results eliminate all infeasible combinations and rank the feasible systems according to increasing net present cost. There are 360 feasible designs for our site under desirable conditions.

After simulating all the possible system configurations, we should select at least one optimum hybrid system, sorted by net present cost, battery life and payback period. A 1.6kW Solar wind hybrid system is the optimum system for this site because this system has lower net present cost, higher battery life with less payback period.

The hybrid system has been designed based on the following steps:

1. Power requirement,
2. Availability of Solar and Wind Resources,
3. Configure the inputs for generating sustainable conditions
4. Simulations of the sustainable Hybrid Systems,
5. Chosen of the optimum system for fulfilling the consumer requirement.

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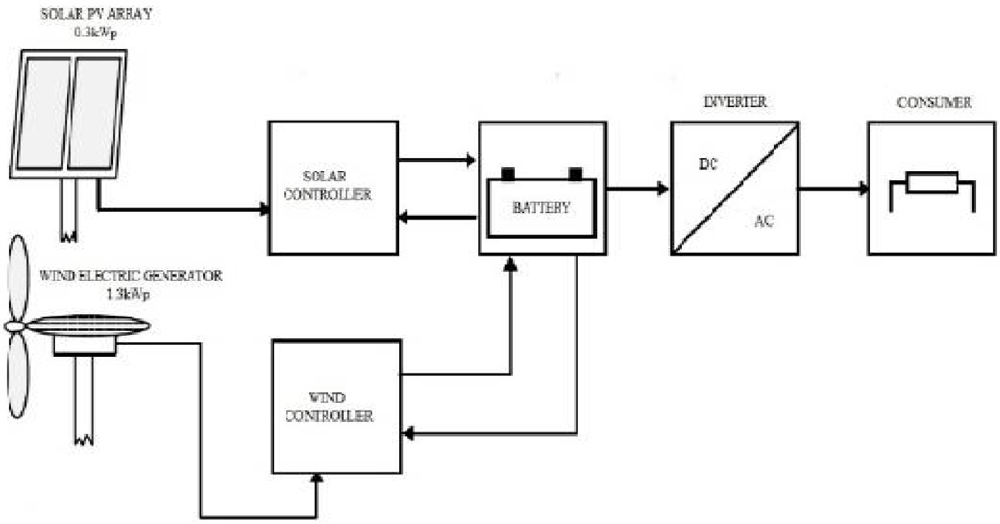

Figure 2: Optimum Solar Wind Hybrid

IV. ABOUT THE HOMER

HOMER, the micro power optimization software developed by Mistaya Engineering, Canada for the National Renewable Energy Laboratory (NREL) USA, used in this analysis simplifies the task of evaluating designs of both off-grid and grid-connected power systems for a variety of applications. In designing a power system, many decisions about the configuration of the system are to be made: components to include in the system design, size of each component to use etc. The large number of technology options and the variation in technology costs and availability of energy resources make these decisions difficult. HOMER's optimization and sensitivity analysis algorithms make it easier to evaluate the many possible system configurations.

HOMER (hybrid optimization Model for Electric Renewable) software is a user-friendly micropower design tool that simulates and optimizes stand-alone and grid-connected power systems. HOMER allows the designer to compare many different design options based on their technical and economic merits. Recently, it has been used widely in the field of renewable energy. It can be used with any combination of wind turbines, PV arrays, run-of-river hydro power, biomass power, internal combustion engine generators, microturbines, batteries, and hydrogen storage, serving both electric and thermal loads. The advantage of HOMER is that it can involve also all costs such as the initial capital and the maintenance costs including pollution penalties.

We can use HOMER to perform analyses to explore a wide range of design questions:

- Which technologies are most cost-effective?
- What size should components be?
- What happens to the project's economics if costs or loads change?
- Is the renewable resource adequate?

HOMER's optimization and sensitivity analysis capabilities help you answer these difficult questions.It performs a sensitivity analysis which can help the analyst to do 'what-if' analyses and to investigate the effects of uncertainty or changes in input variables. The objective of the optimization simulation is to evaluate the economic and technical feasibility for a large number of technology options, while considering variations in technology costs and energy

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resource availability. HOMER produces the amount of emissions of PV and wind-generator system along with the amount of emissions.

V. WHAT DOES HOMER DO

HOMER finds the least cost combination of components that meet electrical and thermal loads. HOMER simulates thousands of system configurations, optimizes for lifecycle cost, and generates results of sensitivity analyses on most inputs.

HOMER simulates the operation of a system by making energy balance calculations for each of the 8,760 hours in a year. For each hour, HOMER compares the electric and thermal load in the hour to the energy that the system can supply in that hour. 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. If the system meets the loads for the entire year, HOMER estimates the lifecycle cost of the system, accounting for the capital, replacement, operation and maintenance, fuel and interest costs. You can view hourly energy flows for each component as well as annual cost and performance summaries.

VI. OPTIMAL SIZE OF THE PROPOSED SYSTEM USING HOMER

The system consists of; PV modules, wind energy system, batteries, charge controller, inverter, and the necessary wiring and safety devices. The system feasibility analysis was performed using the HOMER software. As before we have discussed HOMER is a computer model that simplifies the task of evaluating design options for both off-grid and grid-connected power systems for remote, stand-alone, and distributed-generation (DG) applications. HOMER's optimization and sensitivity analysis algorithms allow one to evaluate the economic and technical feasibility of a large number of technology options and to account for variation in technology costs and energy resource availability. HOMER models both conventional and renewable-energy technologies. HOMER models a power system's physical behavior and its life-cycle cost, which is the total cost of installing and operating the system over its life span. HOMER allows the modeler to compare many different design options based on their technical and economic merits. It also assists in understanding and quantifying the effects of uncertainty or changes in the inputs.

VII. CONCLUSION

Proposed hybrid system will be designed and optimized using HOMER software computer model to supply lighting load. All the optimization systems are ranked according to net present cost, and all other economic outputs will be calculated for the purpose of powering and finding the best net present cost. The result obtained from the optimization gives the initial capital cost as well as operating cost.

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