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SENSITIVITY AND OPTIMIZATION ANALYSIS OF SOLAR PV- WIND HYBRID ENERGY SYSTEM

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Abstract

A sensitivity analysis was carried out to identify the impact of relevant input parameters and constraints on the successful implementation of the system at Energy Park, LNCT Bhopal. The dynamic model of the hybrid power system and its components, established on MATLAB Simulink software, has justified the feasibility of the considered system for the given load demand profile. Hybrid power system has been proposed for Energy Park, LNCT Bhopal to meet the power demand and make it self-sufficient. It is observed that the behavior of solar and wind power sources is complementary to each other, which means that one source at a time exists. Thus, the system reliability of HES is greatly improved. Keeping in view the power load, HES has been designed to achieve uninterrupted power supply at Energy Park, LNCT Bhopal..

Keywords: ***Solar, Wind, Sensitivity, HOMER MATLAB .***

1. Introduction

Energy is an essential part of modern life. The use of energy in various forms helps in meeting the power needs of all important supplies like electricity and water. Over the past century, the rapid growth of the world population with a higher quality of life has increased global energy demand, and it is expected to grow even faster and more Significantly in the near future. In recent years, India's energy consumption has grown relatively rapidly due to population growth and economic development. The rapid growthof the Indian economy creates a high demand for electrical power [1]. Currently, most of the electricity demand is met by coal-fired power plants, putting pressure on fossil fuels. Coal-fired generation is characterized by local and regional environmental degradation as well as greenhouse gas emissions, which cause climate change [2]. All of the disadvantages mentioned above have raised awareness about the environmental impact of fossil fuel use and the risks associated with nuclear power. These have prompted efforts to develop electricity generation technologies that use sustainable and environmentally friendly energy resources. Renewable energy is one of theenvironment-friendly energy sources. There is an assortment of renewable energy resources in a wide range such as wind, solar, fuel cells, biomass, small hydro and geothermal energy. Using more than one renewable energy source to meet the same load is one of the methods used to improve reliability. Energy storage devices and diesel generators are also used to supplement electricity during failure of renewable resources [3]. These types of multi-source energy systems and storage facilities are known as hybrid energy systems (HES). There are many viable configurations. Examples include solar panels; Solar PV Diesel; wind battery; wind-diesel; wind-battery-diesel; Solar PV Battery-Diesel; Wind-Solar PV-Battery-Diesel; Solar PV-Wind Battery; wind fuel cell battery; Solar PV Fuel Cell Battery; Solar Biomass Gasifier Generator Set-Battery; Fuel Cell-Biomass Gasifier Generator Set-Battery; Wind generator-biomass gasifier generator set-battery. Among the configurations above, only the ones that have no diesel generator can be considered renewable energy system. Thus, combining all these renewable energy systems may provide 100% of the power and energy requirements for the load, such as a domestic, Commercial and educational building [4]

2. HOMER

Rapid reduction of conventional power sources and the global warming has blown an alarm to look ahead for some alternate source of different energy source. The ever-increasing demand for electrical energy and the concerns on the natural sustainability all around the world direct to more awareness towards the use of alternative sources for electrical energy production. The need to decrease global warming and the significant increases in the price of conventional energy sources have expectant many countries to provide new energy policies and regulation that promote the renewable energy application. One of the most capable applications of non-conventional energy technology is the installation of the integrated renewable energy system in remote regions where the grid extension is expensive and the cost of energy production growing drastically with the remoteness of the locations.The growing concern in the unconstructive effects of conventional fuel on the environment hasforced a more concentrated use of the non-conventional sources which are considered as animportant solution to the larger ecological pollution caused from conventional energy consumption.Non-conventional energy sources such as wind and solar power have made the public, private andgovernment sectors interested to invest in energy generation from these sources comprehensively.

Renewable energy system such as wind and solar system provide a better trade opportunity for public, private and government sector. The common drawback to wind and solar power system are their indiscriminate nature and they rely on the atmospheric change. On the other hand, various sizing, formulation and simulation model of these systems has been used in various aspects. The essential structures of component of hybrid system basically depend on the type of application. For proper generation of electricity, it is necessary to observe the energy requirement and availability of different non-conventional energy system in the study area. Among wind and solar, wind energy system may not be technically viable at all sites due to random nature of wind velocity integration of two or more resources in a proper arrangement to form a hybrid scheme utilizing the intensity of one source to overcome the flaw of the other is a very good solution. Combined model of solar and wind power system is known as an integrated renewable energy system and is one of the best alternatives of oil produced energy. Based on geological and climate condition of the study area, a standalone solar-wind hybrid renewable energy system is proposed education building India. In the proposed system, solar energy and wind energy will work as the main supplier of electricity along with battery storage, advanced power electronics devices are functioned as supporting elements. The installation of the standalone solar wind renewable energy system with generator backup system is cost-effective and provides environmental sustainability rather than a conventional diesel generator. The data of hourly wind speed, hourly vertical, horizontal solar radiation and load during a year are measured in the region with the help solar and wind velocity measuring instruments.
HOMER is used to design the appropriate system where net present cost is the main criteria. HOMER (3.11.6 Pro) beta micro-grid software provides the detailed analysis of chronological modeling & optimization of a model that is relatively simple easy to use and adapt for a wide variety of grid connected and standalone projects. For a village or community-scale power system HOMER can model the system based on both technical and economic factors which is involved in that project. For larger systems, HOMER can provide an important concept that compares the cost and viability of different configurations. Based on the practical data HOMER software is used for the case study. HOMER software means Hybrid Optimization Model for Electric Renewable, and its simulation is carried out with and without grid connection. Figure 1shows the working steps of cost analysis by HOMER software, which present analysis of hybrid renewable energy system in the form of sensitivity analysis, optimization and mathematical simulation.

Fig.1 Hybrid system component

3. Results

The overall optimization performance of the components of the proposed hybrid energy system has been done using HOMER pro software (version 3.14.5). The RE potential and economic analysis of electricity generation with a hybrid energy system in the Energy Park LNCT Bhopal, in the Indian state of Madhya Pradesh were performed in this study. Different scenarios have been considered and future developments in the fuel price and in the costs for energy (which can be expected to sink due to technical progress) have also been taken into account. The sizing of the various components paid regard to the necessity of an operation reserve to enable the system to provide reliable energy supply and also allows for a rising energy demand in the future. The system's feasibility and itsindependence of the grid are furthered by the sinking costs for HES and the possibility to use a battery bank as back-up, which allows meeting the Energy Park energy demand24/7. For the off-grid electrification of Energy Park LNCT Bhopal various combinations have been obtained of hybrid systems with SPV, wind turbines, batteries and convertors from the HOMER pro Optimization simulation. This is shown in figure 2

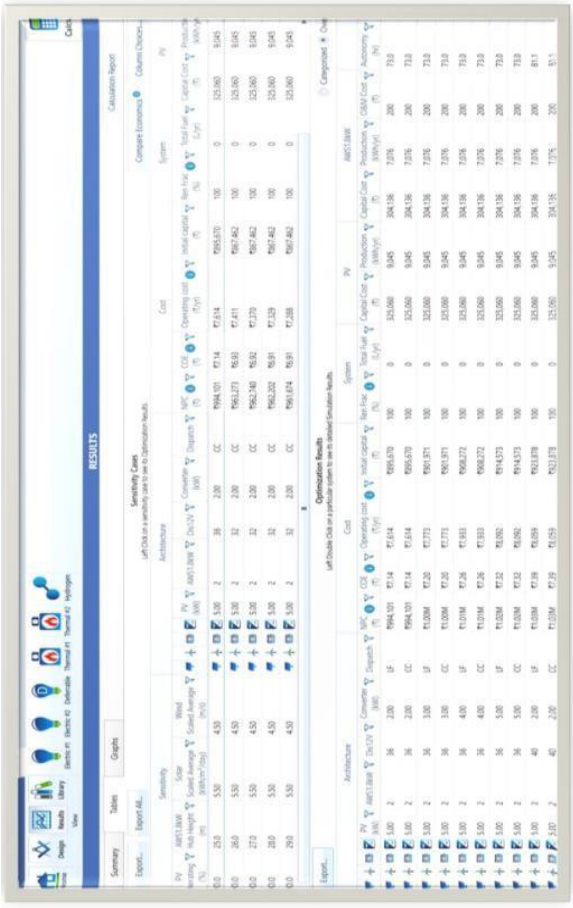

Fig .2 Optimization result details

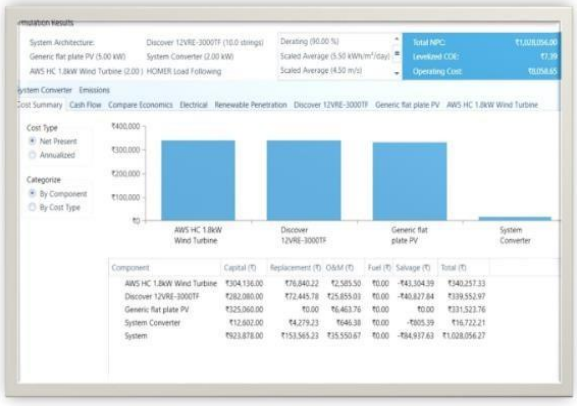

Fig.3 The total NPC, operating cost and COE in proposed system

Fig.3 5.Power production and consumption analysis of proposed system

4. Sensitivity analysis

A sensitivity analysis by entering multiple values for a particular input variable. HOMER repeats its optimization process for each value of the variable and lets you see how the results are affected. An input variable for which you have specified multiple values is called a sensitivity variable. HOMER's most powerful graphical capabilities show the results of sensitivity analyses of two or more dimensions. In this section performedifferent parameter-based sensitivity analysis.

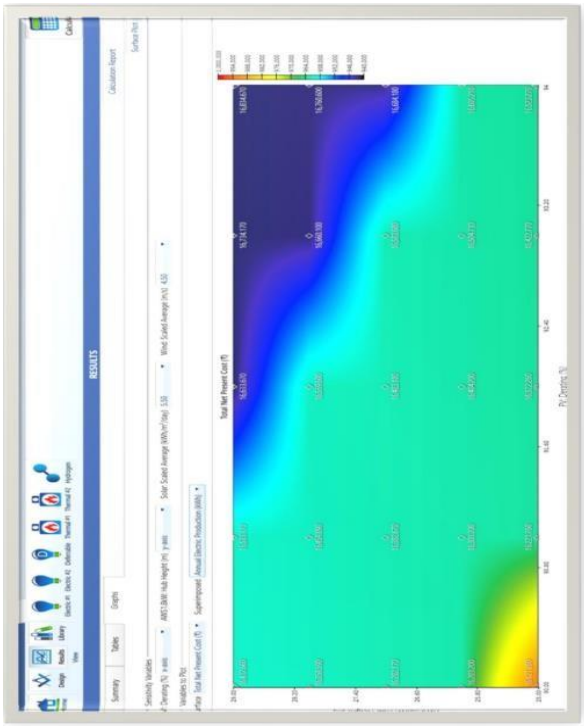

Fig.4 Sensitivity analysis total net present cost NPC (Rs) with solar irradiation 5.5kWh/m2/day and wind average speed 4.5 m/s.

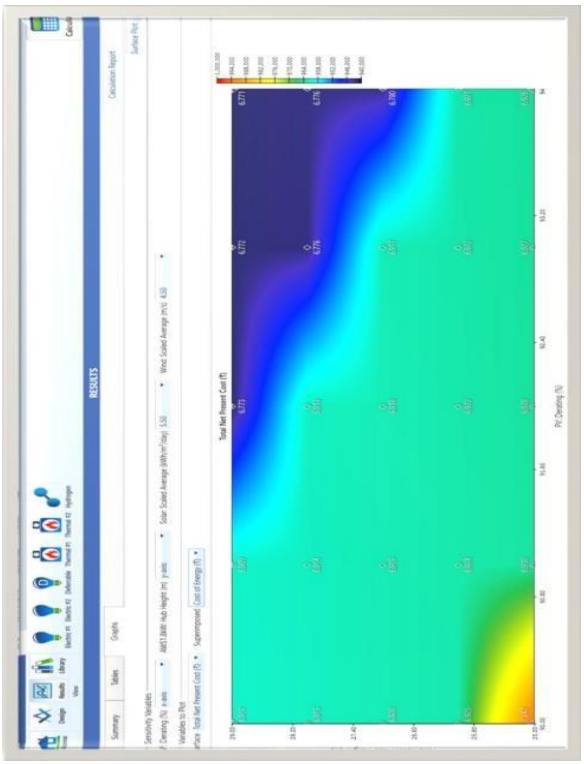

Fig.5 Sensitivity analysis total cost of energy (COE) with solar irradiation 5.5 kWh/m2/day and wind average speed 4.5 m/s.

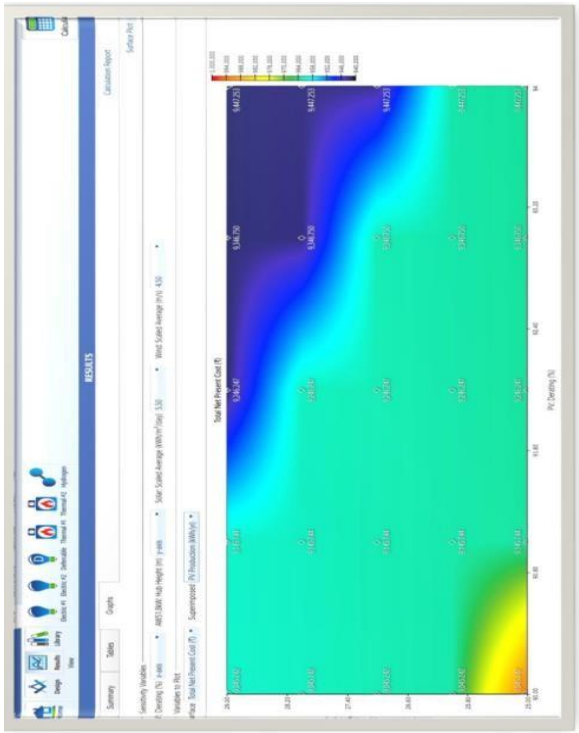

Fig.6 Sensitivity analysis Solar PV energy production (kWh/year) with solarirradiation 5.5 kWh/m2/day and wind average speed 4.5 m/s.

5. Conclusion

The hybrid system. Shifting to Renewable Energy Sources has become the need of the hour, but the dependency of these sources on natural, uncontrollable factors, poses a great challenge. A stable power supply is necessary for a hundred percent shift to renewable sources of energy. This reliability can beincreased in many ways, but here in focus, are Hybrid Renewable Energy Systems (HRES). HRESis an attempt to make a stable energy source that is clean and sustainable. Hybrid energy source is becoming popular because it is containing two or more energy sources. Due to this combination of two energy sources, it is an efficient way of generating energy. Hybrid energy systems are used in remote areas for power generation. This is widely used due to the high prices of oil. The use of hybrid energy systems can optimize the power supply especially in rural areas. However, it is still considered expensive and also it is difficult to combine two or more energy sources together, but it is a onetime expense. This onetime expense can be of many uses to the people living in remote areas. In the realized system, a part of the required energy for an ordinary home has been obtained from electricity that is received from the wind and solar power. Particle setup for the domestic hybrid system consists of a low power wind turbine and two PV panel. Depending on the natural conditions, required energy for the system can be distributed either separately from the wind or solar systems or using these two resources at the same time. Control unit is the deciding factor, which source to use for charging the battery with respect to condition of the source energy.

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