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COST ANALYSIS OF A HYBRID SYSTEM BY USING AN OPTIMIZATION TECHNIQUE

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Abstract

Since the civilization increase around the world and the demand of energy increases on the same ratio. The generation of electrical power is very less as compared to load demand because of limited available sources. Hence if we can use the renewable energy sources and incorporate in to a hybrid system, than crises of energy can be minimized and the production cost of power can be minimized. Hybrid system are environmental friendly and can be installed at remote location were the supply of electrical power is difficult. In this paper we are proposed a hybrid system cost analysis which has wind generation, solar system, and storage battery system and diesel generator. We use an efficient optimization tool HOMER for obtain the optimal cost of the hybrid plant. The main aim of this paper is to find out the optimal cost of the hybrid plant in such a way to fulfill the load demand and minimized the cost.

Key words:- Cost analysis, Homer optimization system, renewable energy sources, Hybrid power generation System.

1. Introduction

Energy plays an important role in all types of development, including economic development the world. Energy consumption increases very rapidly day by day but the rate of power generation not increases on the same ratio. So due to crises of energy development of the world cannot possible. With the current energy consumption rate, proven coal reserves should last for about 200 years, oil for approximately 40 years and natural gas for around 60 years. In this situation we can look for other resources which can use for generation of power. Renewable energy souses is one of the best solution of the problem. But we have to see that the installation cost of solar system is very high and hence power generated by solar power plant increase the cost per unit energy. Similarly the problem with wind energy system is its inconsistency of flow of wind. Hence we can adobe a system which is suitable for fulfill the load demand and most thing that it is reliable.

Hybrid energy system is a combination of different types of renewable energy conversion systems along with conventional in order to fulfill the load demand with more reliability Obtaining reliable and cost effective power solution for the worldwide expansion of telecommunication areas presents a very challenging problem. Grids are either not available or their extension can be extremely costly in telecommunication area. Although initial costs are low, powering these sites with generators require significant maintenance, high fuel consumption. Wind speed of the proposed site must be considerable for easily electrical generation. Wind power with diesel and solar generation has been suggested. Hybrid solar, wind and diesel is very reliable because the diesel acts as a cushion to take care of variation in wind speed and would always maintain an average power equal to the set point. The ability to generate electricity is a building block of modern societies. The utilization of wind turbines to produce electricity has been practiced for over one hundred years.

Energy efficient renewable energy based Base System proposed by the authors of [1] for an isolated location, such as Saint Martin’s Island, has been proposed. The residential consumers use diesel, kerosene and wood for fulfilling their energy demand. Solar and Wind resources are the hybrid options for the Island. The economic feasibility of stand-alone hybrid power system consisting of Biomass/PV/Wind generators discussed by[2] 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 batteries are used to store extra energy generated that can further be used for the backup. This investigation assessed the potential of using solar, wind and biomass renewable energy in hybrid off-grid system. The optimization is realized through the NREL HOMER package. A novel intelligent method [3]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 electrolysers, a reformer, an anaerobic reactor, and some hydrogen tanks. 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)[4]. For this hybrid system ,the meteorological data of Solar Insolation, 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 modelled for optimization of the hybrid energy system using HOMER software.

Here in this paper we are looking to solve the problem of demand of power and minimized the cost of power generation using a hybrid system with the help of HOMER software. This software have the ability to interconnect the different mode of generating plants and optimize the cost of energy in Rs/h.

1.1 HYBRID SYSTEM

Hybrid energy system is a combination of different types of renewable energy conversion systems along with conventional in order to fulfill the load demand with more reliability now this diagram combine for solar\ wind ,fuel and power conditioning and load .the diagram combine for hybrid system used in this paper.

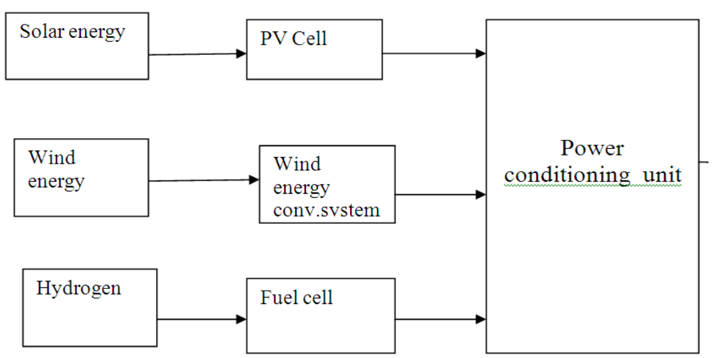


Fig 1.1 Hybrid system line diagram.

It has many advantages over the stand alone system such as it is reliable, economic and environmental friendly. In hybrid system wind power system and PV cells provide DC power. For the conversion of DC power obtained by solar and wind system a semiconductor-based device (power inverter) is used to convert the DC power in to AC power

1.1.2 Homer

The HOMER Hybrid optimization model for electric renewable software is a powerful tool for designing and analyzing hybrid power systems, which contain a mix of conventional generators, combined heat and power, wind turbines, solar photo voltaic, batteries, fuel cells, hydropower, biomass and other inputs. HOMER helps determine how variable resources such as wind and solar can be optimally integrated into hybrid systems. HOMER determines the economic feasibility of a hybrid energy system optimizes the system design and allows users to really understand how hybrid renewable systems work. HOMER can serve utilities, telecoms, systems integrators, and many other types of project developers- to mitigate the financial risk of their hybrid power projects.

1.1.3 How does use HOMER ?

To use HOMER, provide the model with inputs, which describe technology options, component costs, and resource availability. HOMER uses these inputs to simulate different system configurations, or combinations of components, and generates results that you can view as a list of feasible configurations sorted by net present cost. HOMER also displays simulation results in a wide variety of tables and graphs that help you compare configurations and evaluate them on their economic and technical merits. You can export the tables and graphs for use in reports and presentations.

When want to explore the effect that changes in factors such as resource availability and economic conditions might have on the cost-effectiveness of different system configurations, you can use the model to perform sensitivity analyses. To perform a sensitivity analysis, you provide HOMER with sensitivity values that describe a range of resource availability and component costs. HOMER simulates each system configuration over the range of values. You can use the results of a sensitivity analysis to identify the factors that have the greatest impact on the design and operation of a power system. You can also use HOMER sensitivity analysis results to answer general questions about technology options to inform planning and policy decisions.

1.1.3 How does HOMER work?

1.1.3.1 Simulation

HOMER simulates the operation of a system by making energy balance calculations in each time step of the year. For each time step, HOMER compares the electric and thermal demand in that time step to the energy that the system can supply in that time step, and calculates the flows of energy to and from each component of the system. For systems that include batteries or fuel-powered generators, HOMER also decides in each time step how to operate the generators and whether to charge or discharge the batteries.

HOMER performs these energy balance calculations for each system configuration that you want to consider. It then determines whether a configuration is feasible, i.e., whether it can meet the electric demand under the conditions that you specify, and estimates the cost of installing and operating the system over the lifetime of the project. The system cost calculations account for costs such as capital, replacement, operation and maintenance, fuel, and interest.

1.1.3.2. Optimization

After simulating all of the possible system configurations, HOMER displays a list of configurations, sorted by net present cost (sometimes called lifecycle cost), that you can use to compare system design options.

1.1.3.3 Sensitivity Analysis

When you define sensitivity variables as inputs, HOMER repeats the optimization process for each sensitivity variable that you specify. For example, if you define wind speed as a sensitivity variable, HOMER will simulate system configurations for the range of wind speeds that you specify.

2. No of Stages used to Optimized HOMER

1: Formulate a question that HOMER can help answer
HOMER can answer a wide range of questions about the design of small power systems. It is useful to have a clear idea of a question that you want HOMER to help answer before you begin working with HOMER.

2: Create a new HOMER file
A HOMER file contains all of the information about the technology options, component costs and resource availability required to analyze power system designs. The HOMER file also contains the results of any calculations HOMER makes as part of the optimization and sensitivity analysis processes.

3: Build the schematic
HOMER compares multiple technology options for a power system design. The schematic represents all of the technology options that you want HOMER to consider: it is not a schematic of a particular system's configuration. You build the schematic to give HOMER information about the components to consider to answer your question. The schematic may include components that are not in the optimal design.

4: Enter load details
The load details are inputs to the HOMER simulations. The load inputs describe the electric demand that the system must serve. This section describes how to import a sample load file.

5: Enter component details
The component inputs describe technology options, component costs, and the sizes and numbers of each component that HOMER will use for the simulations. This section describes how to enter cost data for diesel generators, wind turbines, and batteries

6: Enter resource details
The resource inputs describe the availability of solar radiation, wind, hydro, and fuel for each hour of the year. For solar, wind, and hydro resources, you can either import data from a properly formatted file, or use HOMER to synthesize hourly data from average monthly values.

7: Check inputs and correct errors
HOMER checks many of the values that you enter in the input windows to see if they make technical sense. If HOMER notices values that do not make sense, it displays warning and error messages on the Main window

8: Examine optimization results
HOMER simulates system configurations with all of the combinations of components that you specified in the component inputs. HOMER discards from the results all infeasible system configurations, which are those that do not adequately meet the load given either the available resource or constraints that you have specified.

9: Refine the system design
This section describes how to use the optimization results to improve the system design. For this example, we will see if adding batteries to the system design will reduce the amount of excess energy produced by the system

10: Add sensitivity variables
In Step Five, you learned that HOMER uses scaled resource data for simulations. This section describes how to enter sensitivity values for both the wind speed scaled annual average and diesel price to perform a sensitivity analysis on these variables. The sensitivity analysis will allow you to explore how variations in average annual wind speed and diesel fuel prices affect the optimal design of the system. Another way to say this is that the analysis will show you the range of average annual wind speeds and diesel prices for which it makes sense to include wind turbines in the system design.

11: Examine sensitivity analysis results
HOMER displays sensitivity results in graphs and tables. This section describes how to view and interpret the sensitivity results to determine under what conditions a wind/diesel system is more cost-effective than a diesel-only system

3. Simulation Model of HOMER

Solar, wind and diesel based hybrid system Simulink model has been developed using homer software version 2.81 and the optimization results are obtained. Here one of the telecommunication exchange office of Bhopal has been considered as case system whose details are given in subsequent section.

3.1 Case system

In present thesis hybrid system has been designed to fulfill the power requirement of the telephone exchange office located in Dist. Bhopal. At this exchange office total 50000 subscribers are connected and the hourly power requirement is shown in Fig. (3.1). The total average value of load is 1800Kw/day.

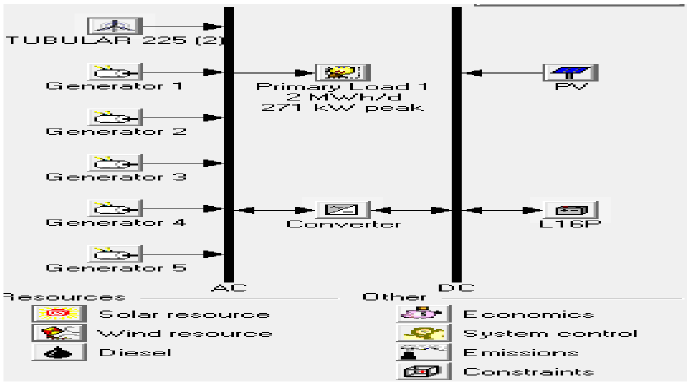


Fig.3.1Simulink model on HOMER

4. Result and Discussion

The model of HOMER is simulated for the data of BSNL exchange for the load demand as shown in fig. 1.

In this work used HOMER 2.81. The objective of design of simulation model of hybrid system is to minimize the total generation costs, while satisfied the specified load. HOMER optimize in such way to give the idea about the different selecting units such as it gives the idea about how many number of wind turbines, solar arrays, diesel generator and how many battery are used to fulfill the demand. On other words we can say that it also select the optimal generation system according to load demand.

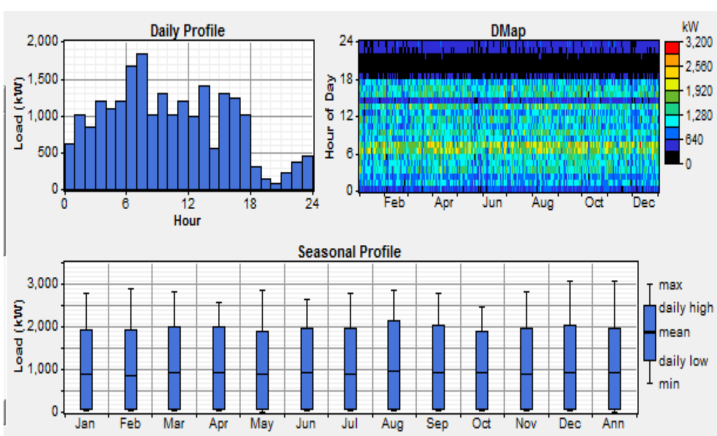


Fig. 4.1 load demand

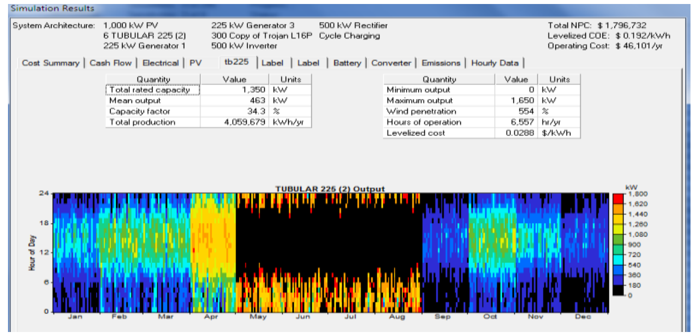


Fig. 4.3Wind Data Output

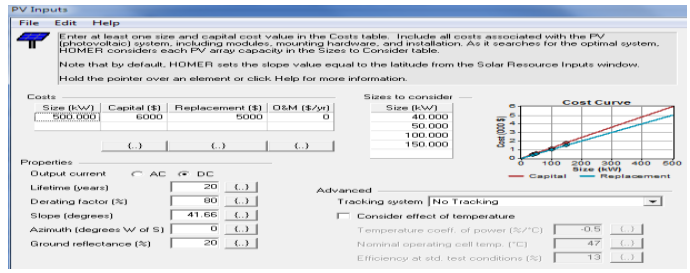


Fig. 4.4 Solar input data

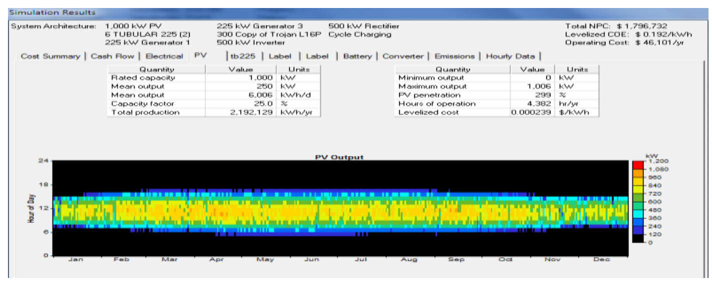


Fig. 4.5 Solar output data

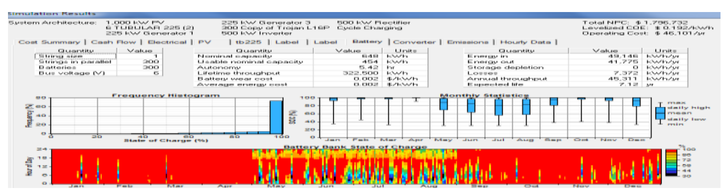
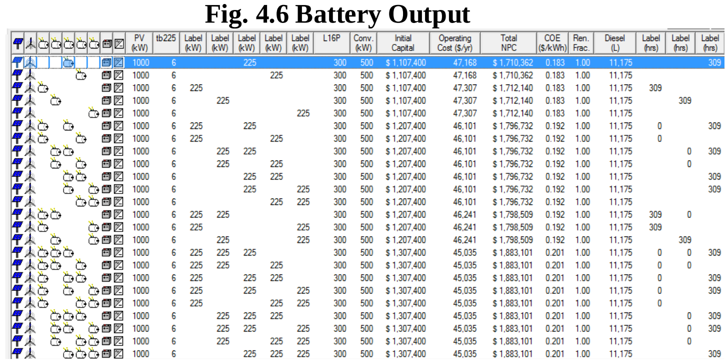


Fig. 4.6 Battery Output



PV (kW)	tb225	Label (kW)	Label (kW)	Label (kW)	Label (kW)	Label (kW)	L16P	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	Label (hrs)	Label (hrs)	Label (hrs)
1000	6			225			300	500	$ 1,107,400	47,168	$ 1,710,362	0.183	1.00	11,175			309
1000	6				225		300	500	$ 1,107,400	47,168	$ 1,710,362	0.183	1.00	11,175			
1000	6	225					300	500	$ 1,107,400	47,307	$ 1,712,140	0.183	1.00	11,175	309		
1000	6		225				300	500	$ 1,107,400	47,307	$ 1,712,140	0.183	1.00	11,175		309	
1000	6					225	300	500	$ 1,107,400	47,307	$ 1,712,140	0.183	1.00	11,175			
1000	6	225		225			300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175	0		309
1000	6	225			225		300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175	0		
1000	6		225	225			300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175		0	309
1000	6		225		225		300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175		0	
1000	6			225	225		300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175			309
1000	6			225		225	300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175			309
1000	6				225	225	300	500	$ 1,207,400	46,101	$ 1,796,732	0.192	1.00	11,175			
1000	6	225	225				300	500	$ 1,207,400	46,241	$ 1,798,509	0.192	1.00	11,175	309	0	
1000	6	225				225	300	500	$ 1,207,400	46,241	$ 1,798,509	0.192	1.00	11,175	309		
1000	6		225			225	300	500	$ 1,207,400	46,241	$ 1,798,509	0.192	1.00	11,175		309	
1000	6	225	225	225			300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175	0	0	309
1000	6	225	225		225		300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175	0	0	
1000	6	225		225	225		300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175	0		309
1000	6	225		225		225	300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175	0		309
1000	6	225			225	225	300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175	0		
1000	6		225	225	225		300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175		0	309
1000	6		225	225		225	300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175		0	309
1000	6		225		225	225	300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175		0	
1000	6			225	225	225	300	500	$ 1,307,400	45,035	$ 1,883,101	0.201	1.00	11,175			309

Fig. 4.7 Simulation results

5. Results and Discussion

Our model was simulated using HOMER, with the objective of minimizing costs, while meeting the specified load. Finding the optimal number of wind turbines and solar arrays to meet the load, as well as the optimal wind turbine height and rotor diameter, was the focus of this study, as well as to test for good complementary characteristics between the wind and solar power systems, and to assess the feasibility of using such a hybrid system to power different applications, such as a station or a village. It is important to note that at first, we tested our model without inputting weather conditions, meaning that the wind speeds and solar radiation were considered constant over the year. In this test, and with a specified load, our model chose to install wind turbines only, no matter what the load, without the use of photovoltaic. This is natural, since wind turbines would generate the same amount of electricity at a cheaper price, as solar arrays are quite expensive, so the model would avoid solar arrays to minimize costs. This means the model went against our hybrid idea, and chose to have one system only. However, this shows that we need a hybrid system only to take advantage of their complementary characteristics, because wind and solar radiation are not constant over the year as we specified in our test; in Middle Eastern countries for example, when there is a shortage of wind in summer, there is an abundance of solar radiation, meaning that wind turbines may not be able to meet demand on their own in summer, and may require another source to make up for the loss in power generation. To test this, along with the feasibility of the hybrid system for different applications, we again ran our model, but this time using weather-generated data that is typical of Middle Eastern countries such as the UAE and Oman. Using weather data from these countries is suitable, since desert conditions exist in many remote/rural areas found in third world countries. Figures show the solar radiation and the wind speed as a percentage of the maximum attainable from each resource separately, over the course of a year. The generated data was plotted, and a best-fit line was drawn.

6. CONCLUSION

In the current work HOMER version 2.81 has been successfully used to determine the optimal combination of solar, wind and diesel based hybrid system to fulfill the load requirement of telecommunication site in BSNL Bhopal. The results obtained are concluded as given below:

The monthly average Electric production of the system photovoltaic production is 35%.and wind is 50% .total net present cost NPC .Capital cost and cost of energy for such A system**. Total net present cost NPC-$3756032, capital cost of energy -$0.401,intial cost-$1253,200 and operating cost-$195788.** Respectivily for one year payback time is 25 years. In india more than 2 billion peoples are sell phone. To provide better network services sell phone operator installed new sell phone base station. Power is main issue for telecom base station, because grib extension is not feasible. This sites proposed renewable base hybrid system is most viable solution. .Alternate power solution are not commonly used in tower telecommunication system today but are actively evaluated for remote and isolated areas over worldwide .with the help of above pre feasibility study the solar and wind hybrid energy system are most viable power solution for cell phone base station in Indian sites over conventional diesel generator .Although the net present cost is high but the running and maintenance cost are low as compared to the diesel generator power solution.

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