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AC-DC Hybrid Micro-grid Economic Optimization by using Homer

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Abstract

Hybrid Energy system composed of proper interconnection of Renewable as well as non-renewable energy system can help in improving the economic and environmental sustainability to cope with the high energy demand. It may consist of many sources like Photovoltaic, solar, thermal modules, fuel cells, wind turbine and biomass plant working together as a unit of system interconnected to respective AC or Dc buses. In this paper we study one of the cases of hybrid power generation system suitable for remote commercial buildings or small industry. Here we have taken a case study of Bharat Sanchar Nigam Limited (BSNL) telecom. Exchange office, data and that is analyzed by hybrid optimization.

This work proposes the cost analysis of hybrid system using HOMER Pro 3.4.2 software. Complete proposed system has been optimized as per operational cost, environmental variables and load demand at a particular time so as to provide the cheapest operation, maintenance and fuel costing using Simulation results of HOMER. The greenhouse gasses emission has also been considered as included in result and discussions.

Introduction

The need for energy-efficient electrical power sources in remote locations may be a drive for analysis in hybrid energy systems. Power utilities in several countries round the world area unit amusing their attention toward additional energy- economical and renewable electrical power sources. The employment of renewable energy sources in remote locations may facilitate cut back the expense through the reduction in fuel consumption, increase system potency, and cut back noise and emissions[1].

Hybrid system is a connection and arrangement of different renewable energy systems along with the standard energy system so as to meet the load demand with greater reliability. In this thesis work we consider the following diagram which is a combination of solar and wind, conventional fuel system to power electrical loads of telecommunication exchange. The diagram below for hybrid energy system is used for the study and simulation[2].

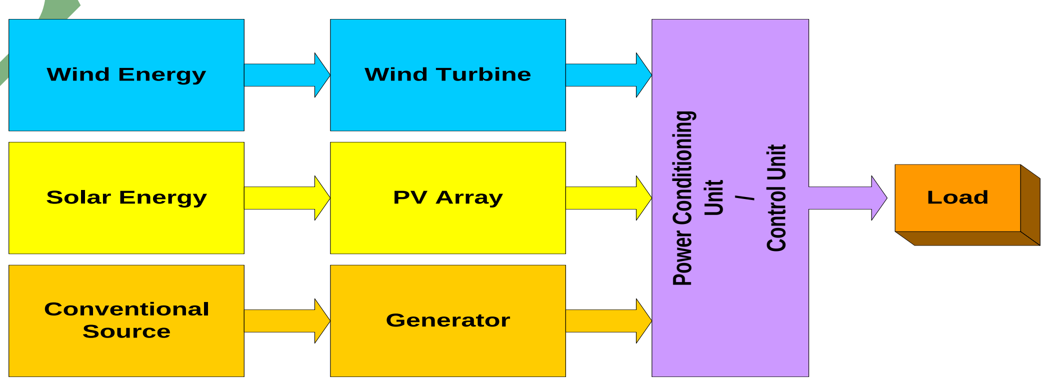

Figure 1-1: Solar and wind Hybrid system

HOMER

HOMER is a tool developed for simulation, Planning and design of Renewable energy hybrid system in Micro grids[3]. HOMER is a GUI based powerful optimization tool for design and analysis of hybrid systems of multiple sources. Hybrid system may be containing various sources like DG, WTG, SPV, battery Banks, hydro Turbine, biomass, Fuel Cell etc and other loads can be AC, DC, Battery Charging, combined heat and power loads etc can be optimized for best economic results by using Homer. HOMER helps various resources like wind and solar power to optimally perform for hybrid power systems. HOMER simplifies the optimization of grid connected and off-grid Microgrids system connected to distributed loads[4]-[6].

Optimization methods have extended in the electric industry for obtaining best solution of designed system. Optimization techniques can handle nonlinear system and provide best solution of such problem. Optimization techniques used in various areas such as:

- State estimation,
- Transmission line expansion and planning,
- Distribution system,
- Voltage control,
- Wind power,
- Security stability,
- Layout and Arrangements of equipments,
- Distributed generation and Micro grids.

ALGORITHM OF HOMER

Step 1: Formulation of problem that we need to solve from the HOMER.

HOMER can optimize a wide range of problems about the configuration of hybrid power systems. It is desired to have clear idea about what we need to optimize and the problems of design before we start the simulation using HOMER

Step 2: Obtaining a new fine HOMER design.

Homer file is capsule of all information and input variable needed for simulating the design like cost of components, load requirements, resources availability and various other technical consideration about the model.

Step 3: creating schematic of System

HOMER compares all available technological options for microgrid hybrid system design. System schematics represent all technological consideration chosen for the system design. To obtain the optimization it is needed to provide schematic of component interconnection and design scheme to the HOMER. The schematic may or may not contain the component chosen in design optimization.

Step 4: Enter load details

Homer need some input for simulation like the load details which must be provided as inputs to the HOMER. These input are data of load demand that system must meet during its operation.

Step 5: Enter component details

The component details are provided to homer for technical optimization, it includes the rating, size, component cost, number of each component these data is being used during the simulation. This section provides the way to enter cost data for solar cell, diesel engine generators, wind generator turbines and batteries units.

Step 6: Enter resource details

Resources details are provided to homer for the site of setup of microgrid, these are fuel and environmental factor like solar insolation, Wind speed at site, hydro and fuel availability and cost, inflation details etc. These details can also be imported from various sources provided by HOMER like NASA Surface metrology and solar energy database and others. It can also be gathers by surveying at the site using proper data acquisition tools.

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Step 7: Check inputs and correct errors

HOMER also verify the data entered in the input window for its technical validity. It displays warning massage on main window for those data that does not make sense technically.

Step 8: Examine optimization results

HOMER simulates the designed configurations accounting for components that we specified and the related data we provided. It discards all irrelevant system configurations from the optimization result that do not adequately meet the desired load demand or resources available and constraints specified.

Step 9: Refining the system configuration

This section suggests the optimal design using simulation result. For a case, we see that addition of number of units of batteries schematic tends to decrease the amount of extra power generated by the system.

Step 10: Adding sensitivity variables

In above step we got to know that HOMER uses simulates design for scaled resource data. This part suggests the way to provide sensitivity values for wind speed annual average and fuel price to perform a analysis on these inputs. This analysis helps us to explore the effect and enhances the system performance considering the effect of increasing fuel price and varying wind speed throughout the year i.e. the analysis show us the range of annual wind speed and fuel prices so that analysis can be performed and decision can be taken whether to include the component in the system or not.

Step 11: Examine sensitivity analysis results .

Simulation of this analysis is displayed in results in the form of graphs and tables. This section suggests the manner in which these data can be interpret and used to determine the most cost effective timing for operation of wind system or diesel system[7].

CASE STUDY DESCRIPTION

Here in this thesis the model has been designed to meet the load requirement of BSNL telecomm exchange. At this exchange office of total ---------- subscribers are connected and the hourly load demand and power consumption is shown in Fig. (5.2). Total average value of load is 1800Kw/day[8].

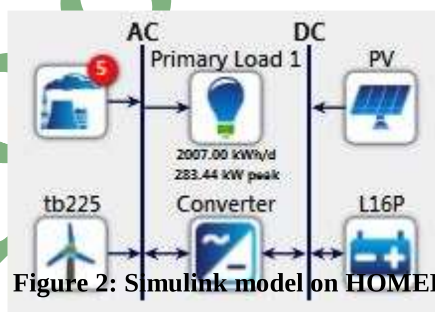

Figure 2: Simulink model on HOMER

- There are 5 different generator set connected to AC bus of 100 kW each. Fuel curve of generator 1 is presented below.

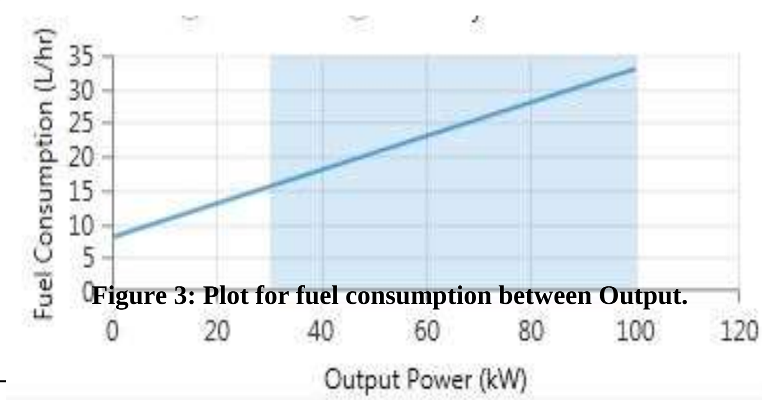

Figure 3: Plot for fuel consumption between Output.

Result & Discussion

Focus of study in on evaluation of proper number of wind turbine, solar cell units, duration for operation of DG sets for optimal operation as well as to meet the desired load demand. In the mean time it is also evaluated for complementary char between the renewable sources of proposed microgrid. This is also for the study of compatibility of using this hybrid system to electrify different loads and load demands, such a load as present in BSNL telephone exchange.

Table 1: Experimental Setting

Components	Size (kW)	Capital (Cost in $)	Replacement (Cost in $)	O&M (Cost in $)	Lifetime (Years)
PV Panel	500	6000	5000	00	15
Wind Turbine	0.4 (3 Units)	1000000	1000000	12000	15
Solar Battery	2.234 (500 Units)	500	500	50.00	15
Converters	500	900	900	0	15
Generators	100(5 Units)	100000	60000	0.050	15

Table 3: Power Generated per year for individual sources

Component	Production(kWh/yr)	Fraction (%)
PV	265,219	33
Generator	17,492	2
Generator	187,125	23
Generator	337,630	42
Wind Turbine	5	0
Total	807,472	100

Table 2: Electrical Output:

Quantity	Value	Units
Excess electricity	14256	kWh/yr
Unmet load	89	kWh/yr
Capacity shortage	89	kWh/yr
Renewable fraction	0	

In figure 4 Output Data comparison between Ac Primary Load, Excess Electrical Production and Total renewable Power output has been plotted clearly shows how the renewable power generation (Blue) has helped to meet the load demand (Red). Black lines represent the AC load demand the remaing demand can be filled with DG set. One interesting fact as seen in figure is excess electricity produced which can be sold to grid (in case site is grid

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connected) or sold to local users. A instantaneous data is colledted from the plot to show it for example. It is found that AC load demand is 149.43 kW, renewable power generated is 84.05 kW and 37.43 kW is excess Power generated.

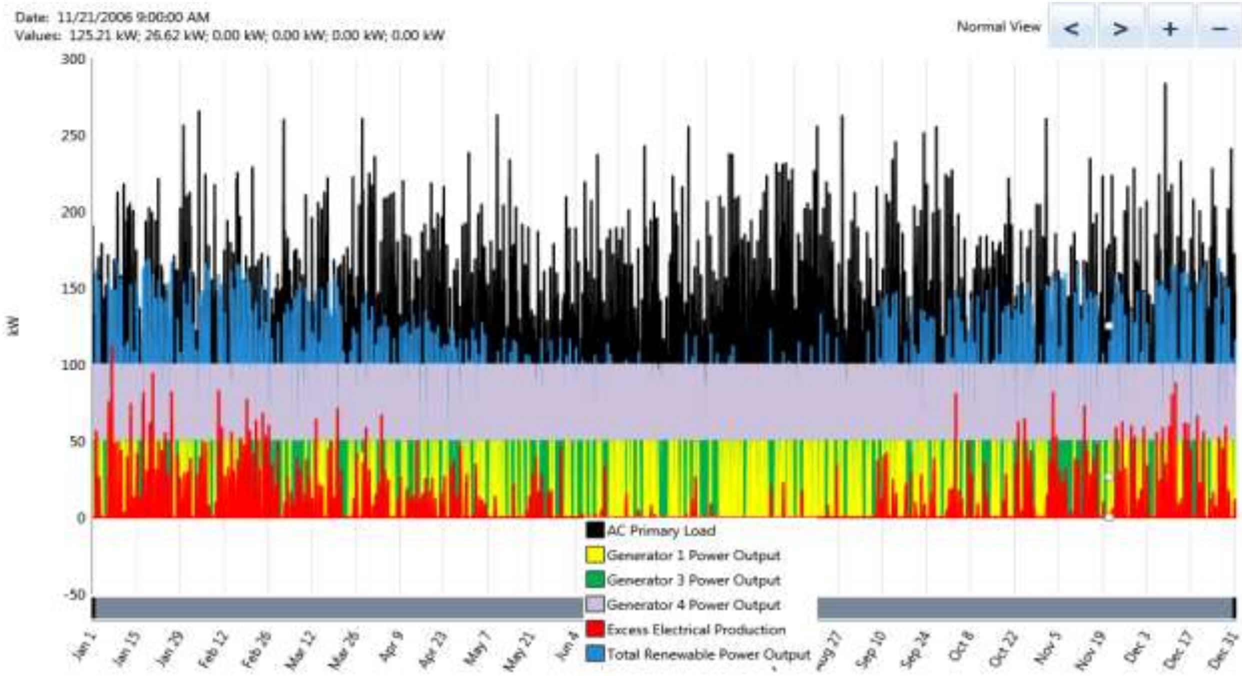

Figure 4: Output data comparison between ac primary load, excess electrical production and total renewable power output

Conclusion

This thesis proposes a hybrid microgrid system for a remote telecom. Site and a case of study of such a site have been taken as BSNL, Bhopal. Here the system sizing the design of configuration has been proposed with optimal operational cost. As per Indian scenario there are aprox. 2 million cell phone users are present and every city and town has a cell phone base station located by many telecommunication providers for better service, continuity in power is point of concern for these telecom base stations, as the grid power supply is not reliable. Hybrid microgrid power generation at these sites is most viable solution. As discussed and proposed model in this thesis proves to be most economic and viable solution to cope through power issue by using renewable power generation sources of wind and PV which proves to b more economic too over the conventional power sources. One might observe that the initial cost i.e. NPC is higher in hybrid system but the running and maintenance cost is quite lower than conventional diesel operated engine.

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