Available online at www.sciencedirect.com
ScienceDirect
Procedia Technology 24 (2016) 499 – 504
Procedia Technology

International Conference on Emerging Trends in Engineering, Science and Technology (ICETEST - 2015)

Optimal Design Configuration Using HOMER

Prashant Kumar[a],Rahaul Pukale[b],Nilesh Kumabhar[c],Utkarsh Patil[d]

[a]*AMGOI,Wather,Kolhapur,416112,India*
[b,c,d]*AMGOI,Wather,Kolhapur,416112,India*

Abstract

Target of the paper is to presents an idea about to design, simulation and analysis of stand-alone hybrid renewable energy resources for a typical ATM machine in remote locations. The main task of this paper is to give optimal solution to solve the problems of energy crisis in the globe. In current scenario the non-renewable sources are available in plenty amount to full fill our increasing demand. Considering the above information we have made an effort to analyze advantage of Distributed Generation considering solar power or wind power, alone can fluctuate, when connected together they provide reliable source of energy as diesel generator is used as backup unit for emergency. So the combination of these two forms of energy source with diesel generator provides reliable generation to provide a constant source of energy flow for the designed system. The main motive of this paper is to study feasibility of solar-wind-diesel hybrid power system with maximize the use of non-conventional generation system while minimizing the total system cost.

Peer-review under responsibility of the organizing committee of ICETEST – 2015

Keywords: Distributed Generation; HOMER software; Optimal Cost; Renewable energy

1. Main text

In recent era there is a great scope for advancement in power generation considering environment friendly technology such as renewable energy technology is becoming, as technically viable and environmentally friendly. Around the world, effort is being made to study the viability of renewable energy incorporated hybrid system as alternative of diesel generator. The hybrid energy system generally works with primary renewable source in parallel combination of a standby secondary non-renewable module and storage unit. In village hybrid energy system offer an

Corresponding author. Tel.: +918928048180
E-mail address: prashant2685@gmail.com

Peer-review under responsibility of the organizing committee of ICETEST – 2015
doi:10.1016/j.protcy.2016.05.085

attractive and practical solution to meet electrical power demand in rural communities around the globe. [5], [9]

Main drawbacks of the standalone system considering solar as well as wind energy is the energy fluctuation, resulting in intermittent delivery of power and causing problems if reliable and continuous supply is required. So such types of problems can be overcome by the use of standalone hybrid systems. A hybrid power system can be defined as a combination of different source of energy, but complementary energy generation system can be provided by renewable energy or mixed (RES- with a backup of diesel generator set). Hybrid systems provides the better features of each energy resources as compared to conventional sources and also provide "grid-quality" electricity, with a power range of kilowatt to several hundred kilowatts.

The major advantages of a hybrid system are that, when one power source is at low levels the other source is usually at higher levels. Solar panel is less effective on cloudy, windy day so it will produce lower energy levels while wind generator may be producing a lot amount of energy. Similarly, for wind generation the main issue is location of the site, which has a certain amount of wind on regular basis. The major use of non-conventional energy makes this system almost independent and lowers the energy prices over the long-term, and diesel generator combination is used as back up in emergency such as high loads or low renewable power availability.

This case study is done on the ATM machine in remote area where grid connectivity/extension is difficult, in our case study Vathar, Kolhapur area is considered whose latitude is 17o 53' 0" North and longitude is 74o 9' 0" East. [2]

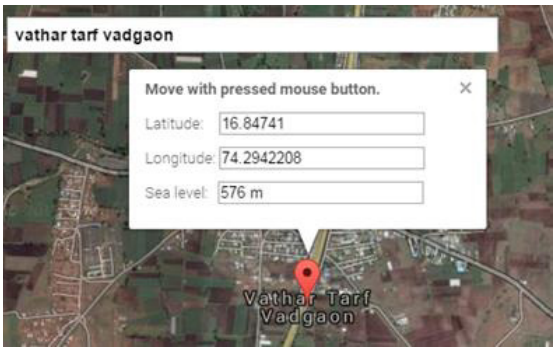

Fig.1.Geographical view of vathar.

1.1. Advantages of distributed generation

The basic tangible benefits of distributed generation are as follows

- With prefabricated standardized components helps in easy and faster installation
- High voltage Transmission over long distance are economical
- Eco-friendly means reduction of emission by use of renewable energy sources
- Running cost more or less constant over the period of time with the use of renewab sources
- Less complexity encourages possibility of user-operator

1.2. HOMER software

HOMER means Hybrid Optimization Model for Electric Renewable. It is most widely used Software. HOMER is developed by Mistaya Engineering, Canada for the National Renewable Energy Laboratory (NREL) USA in 1993. It is micro power optimization model that ease the task

of evaluating designs of both off-grid and grid-connected power systems for a various applications [1]. HOMER does both optimization and sensitivity analysis. With the help of HOMER, system performs the energy balance calculation considering several numbers and sizes of component. A sorted list of configuration result based on the Total Net Present Cost (TNPC) has been displayed on the software. The system takes account the calculations for costs such as capital, replacement, operation and maintenance, fuel and interest. Sensitivity analysis determines varying factors such as wind speed, fuel cost. HOMER displays simulation results in a variety of tables and graphs which helps to compare configurations and evaluate them on their economic merits.

2. Methodology

The considered simulated hybrid renewable energy system consists of wind turbine, photovoltaic (PV) array with power converter, battery and Diesel generator. In case of an emergency battery is used as a backup unit for the considered system that acts as a storage medium. Considered system is designed specifically for an off grid case for a college to supply 24/7 bases. Especially this system is designed for ATM machine. The data required for solar and wind resources for the Automatic Teller Machine site was taken from online data of NASA methodological department. The survey has been made to plot a graph between daily load profile and energy consumption of ATM. The HOMER software is used to perform the determination of optimal sizing and operational strategy for a hybrid renewable energy system that based on three main tasks which are simulations, optimization and sensitivity analysis. The following discusses on three principle tasks of the HOMER software.

2.1. HOMER: Simulation

Design of the considered system based on the selection of components by the design engineer. In this process, energy balance calculation will be performed by HOMER based on the system configuration comprising several numbers of sizes of component. Here the considered components are PV array, wind turbine, diesel generator with battery and converter for the purpose of analysis [6], [10]. After simulation, it determines the best optimal system configuration which is suitable to provide the energy demand. HOMER will simulate the designed system based on the estimation of installing cost, replacement cost, operation and maintenance cost, fuel and interest rate [6].

2.2. HOMER: Optimization

The optimal solution is obtained after simulating the entire possible number of selections of hybrid renewable energy system configuration. A list of configuration result displayed in a sorted form considering Total Net Present Cost (TNPC). HOMER analyzes the different types of system configuration from the lowest to the highest TNPC. However, the system configuration based on TNPC is varied depending to the sensitivity variable that has been selected by the designer.

2.3. HOMER: Sensitivity Analysis

The HOMER software will perform the iterations to get optimal result for every selection including sensitivity variable for the hybrid renewable energy system. The sensitivity variables are such as the global solar, wind and cost of diesel fuel. A list of various system configurations of designed hybrid renewable energy will be presented in tabulation form considering cost wise analysis i.e. lowest to the highest TNPC. The optimal solution means a hybrid renewable energy system having lowest TNPC.

3. Designed System Model

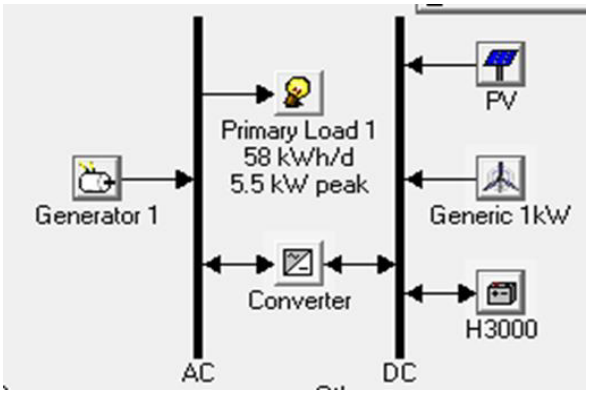

Fig.2. Schematic diagram of hybrid system

3.1. Solar PV Array

In a PV Array, semiconductor material absorbs photons from solar radiation, which are converted into a voltage through the movement of electrons. Module is produced by combining PV cells together. Modules put together to form array. Solar resource means the amount of global solar radiation that strikes earth's surface. Solar radiation for this study area was obtained from the NASA Surface Methodology. An average solar irradiation of 5.165 kWh/m2/day and clearness index of 0.539 is obtained for the study area. In this case the 15kW PV array is used.

3.2. Wind Resources

Utilizing wind mills for various reasons is a practice for several years. Now many nations recognize the importance of wind energy. The wind energy has re-emerged as important source of sustained energy resource worldwide. The average wind speed is 3 m/s for the study area. In this case the 3kW wind turbine is used.

Table 1.Laod Data.

Name of items	Quantity	Power (kW)	Total Power (kW)
ATM	2	0.7 each	1.40
Lightning	6	0.09 each	0.54
Air conditioner	1	1.60	1.60
Hub	1	0.32	0.32

3.3. Diesel Generator

Diesel generators are mainly used for off-grid generation. Low installed capacity, high shaft efficiency, suitable for start stop operation and high exhaust heat are some advantages of diesel generator. In this model 2.6kW capacity diesel generator is used.

3.4. Converter

Here converter is used in both mode rectifier and inverter. The bidirectional converter both capital cost and replacement cost are assumed to be 83$ for a lifetime 30 years. The size of the converter is 6kW.

3.5. Battery

Hoppecke 24 OPzs 3000 battery is considered in schematic diagram as because it is capable of giving required backup during emergency such as load-shading. The capital costs and replacement cost both assumed to be 1370 $.

3.6. Load Descriptions

A typical ATM is taken for the case study.
Average load = 57.8kW
Peak load = 5.48kW and the load factor is 0.439.

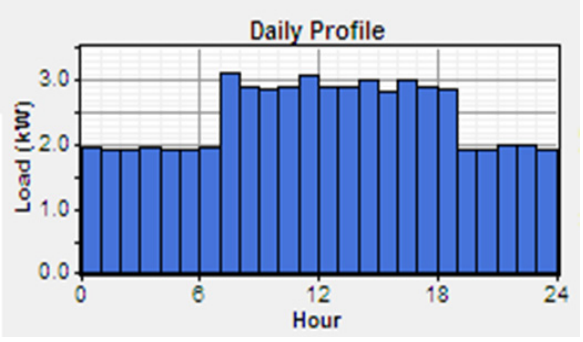

Fig.3. Daily load profile curve of ATM.

4. Result and Discussion

4.1. Optimization Result

The HOMER software will repeat iterations for the optimal result for every selection sensitivity variable for the hybrid renewable energy system.

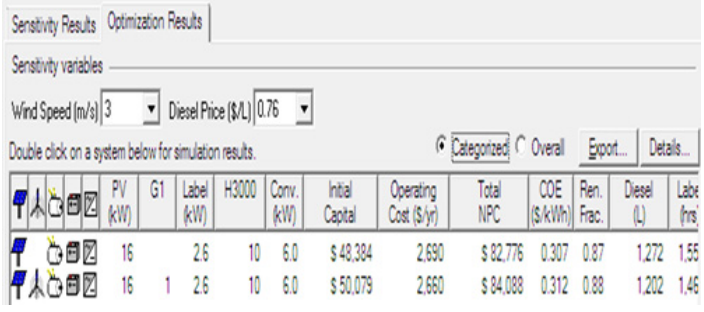

Fig.4. Optimization result.

From the optimization result the best optimal system designed solution in which energy source components are solar, diesel and battery.

4.2. Sensitivity Analysis

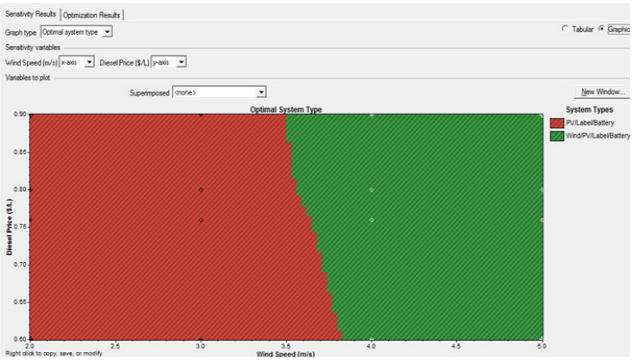

Fig.5. Sensitivity analysis result.

5. Conclusion

In this work we proposed hybrid power generation system for the ATM machine. All the optimization systems are listed as per the NPC and economic values are calculated for the purpose of powering the ATM machine and finding the optimal Net Present Cost (NPC). The results obtained from the HOMER in our case study gives the optimized Initial Capital Cost is 48384 $, Net Present Cost is 82775 $, Cost Of Energy is 0.307 $.

The price of energy of the optimal system is lesser than that of the grid provided cost of energy. Although initial cost of solar-wind-diesel is high, but it electricity at lesser cost.

Acknowledgement

I, Prashant Kumar very thankful to my wife Mrs. Shipra Kumari for support and editing of manuscript.

References

[1] Bidisha Roy, Ashoke Kumar Basu, Subrata Paul, “Optimal design of a grid connected solar photovoltaic power system for a residential load.,”
[2] Michael S. Okundamiya, Vincent O. A. Akpaida, Benedict E. Omatahunde,“Optimization of a hybrid energy system for reliable operation of automated teller machines.
[3] D. Suchitra, R. Utthr, Dr. R. Jegatheesan, B. Tushar, “Optimization of a PV-Diesel hybrid Stand-Alone System using Multi-Objective Genetic Algorithm
[4] Prof. Dr. M. F. Al_Kababjie, W. H. Hamdon “Performance Evaluation study of Hybrid Generation System (Microhydro + Diesel) in Iraqi Remote Rural Electrification”
[5] J. K. Maherchandani, Chitranjan Agarwal, MukeshSahi “Economic Feasibility of Hybrid Biomass/PV/Wind System for Remote Villages Using HOMER”
[6] A. Rodrigues, T. Dentinho, C. Silva, E. Azevedo “Cost Benefit Analysis to select clean energy solutions in dairy farm milk collection posts in Azores”
[7] Parita G Dalwadi, Chintan R Mehta, “Feasiblity Study of Solar-Wind Hybrid Power System ”
[8] Majid Alabdul Salam, Ahmed Aziz, Ali H A Alwaeli, Hussein A Kazem, “Optimal sizing of photovoltaic systems using HOMER for Sohar,Oman”
[9] ZalalemGirma, “Hybrid renewable energy design for rural electrification in Ethiopia”
[10] Hani S.Algnaahi, Kamaruzzaman S., Mohamed A, Ahmed M. A. Haidar and Ahmed N. Abdalla “Experimental study of Using Renewable Energy in Yemen”
[11] BinduKansara, Prof. (Dr.) B. R. Parekh,“Modeling and simulation of Wind-Diesel hybrid system.”