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Optimium Planning of Hybrid Renewable Energy System Using HOMER

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ABSTRACT

A hybrid renewable energy system may be used to reduce dependency on either conventional energy or renewable system. Optimization of hybrid renewable energy systems looks into the process of selecting the best components and its sizing with appropriate operation strategy to provide cheap, efficient, reliable and cost effective alternative energy. In this paper a methodology has been develop for optimum planning of hybrid PV-Wind system with some battergy backup. The local solar radiation, wind data and components database from different manufactures are analyzed and simulated in HOMER to assess the technical and economic viability of the integrated system. Performance of each component will be evaluated and finally sensitivity analysis will be performed to optimize the system at different conditions.

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1. INTRODUCTION

The application of renewable energy system has become an important alternative as power provider in rural electrification program [10]. When the conventional sources are depleted and the price of oil reaching its highest level. Applications of renewable energy at this location are through solar radiation via photovoltaic (PV) panels, wind turbines and battery. Initially, the system is a single source system. However a single renewable energy usually tends to be oversized to accommodate load demand. A combination of one or more sources of renewable enegy called hybrid will improve load factors and help on maintainence and replacement costs as the renewable can complement each other [1]. However the evaluation of the correct type of renewable energy system needs to be done so that the system can be optimized [10].

Wide studies have been done to evaluate the competitiveness of renewable energy system as alternatives to the diesel generator such as by Schmid and Hoffman [1]. In literature, several papers have studied the design and planning of hybrid enewable energy system (For example: Paska etal [2009]; Ashok [2007]; Ekrm and Yetkin Ekran [2008]) [11] [12] [13]. The aim of this paper is to present optimum planning of hybrid solar PV and wind renewable system with battery backup and find out the optimum solution of resources based on economics. The approach is based on mathematical modelling of each component, and then the optimization problem is solved by HOMER in order to better manage and control the energy flow so to ensure reliable supply of demand.

2. RESEARCH METHOD

The proposed hybrid renewable is consiste of wind turbine and solar photovoltaic (PV) panels with battery, generator and inverter are addes as part of back-up and storage system. The proposed system is shown in Fig1. The study involves a theoretical load demands as shown in Table 1 and Fig. 2.

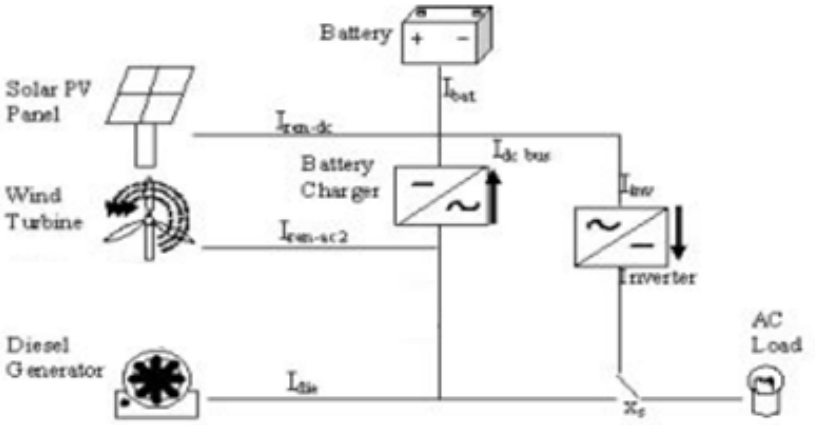

Figure 1. Block diagram of hybrid renewable energy system

Table 1. Theoretical Demand Load

Time	Tube light	Fans	T.V	PC	Fridge	Pumps	Others	Total W/Hr
12	400	2535			330			3265
01	400	2535			330			3265
02	400	2535			330			3265
03	400	2535			330			3265
04	400	2535			330	7500		10765
05	400	2535			330	7500		10765
06				**Load Shading**				
07								
08			1400		330	7500		9230
09			1400		330	7500		9230
10					330	7500		7830
11		2535		2500	330	7500		12865
12		2535	1400	2500	330			6765
01		2535	1400	2500	330			6765
02		2535	1400	2500	330			6765
03		2535	1400		330			4265
04		2535			330			2865
05				**Load Shading**				
06								
07	24000				330			24330
08	24000	2535			330			26865
09	24000	2535			330			26865
10	24000	2535			330			26865
11	400	2535			330			3265

The load is assumed constant all year. The renewable energy supplied is based on hourly basis as the fluctuation of parameters involved in wind turbines and solar PV.

2.1 Proposed Location of Hybrid System

The site of the integrated renewable system is located in Yavatmal district, Dudhagaon village in Maharastra India.

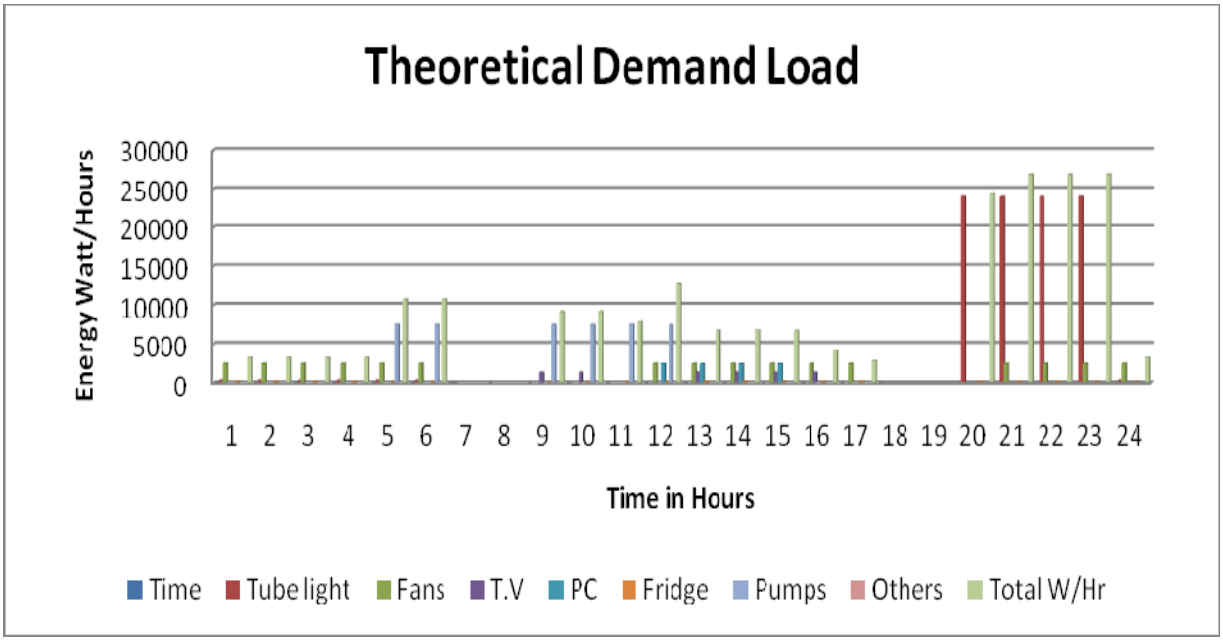

Figure 2. Graphical representation of Enargy requirement per hour

2.1.1 Solar PV Panels

As per the proposed work we are consider that there are ten PV panels with each has a capacity of 1Kw. The initial cost of the panels is $7000 and replacement cost for each panel is $7000. The lifetime of the panels will consider to be 20 years. The monthly average daily solar radiation in Yavatmal is between 5.24 Kwh/m2/day with the monthly average daily sunshine duration ranging from six to eight hours as shown in table 2. These values are important for sizing of solar energy system.

Table 2. Solar Resource Input

Month	Clearness Index	Daily Radiation (Kwh/m^2/day)
January	0.643	4.748
February	0.658	5.516
March	0.617	5.911
April	0.641	6.733
May	0.603	6.596
June	0.474	5.228
July	0.365	3.990
August	0.379	4.023
September	0.514	5.075
October	0.633	5.516
November	0.652	4.947
December	0.666	4.689

2.1.2 Wind Turbine

The wind turbine has a capacity of 1 Kw, its initial cost is $2100 and its replacement at $1800. Annual operation and maintance cost is $50 per year. Its hub and anemometer is proposed to located at 25 m height. Lifetime is assmed for 15 years. The average wind speed for this location shown in table 3.

Table 3. Wind Resource Input

Month	Wind Speed (m/sec)
January	2.948
February	2.082
March	2.287
April	1.857
May	1.571
June	1.687
July	1.487
August	2.035
September	1.533
October	1.829
November	1.800
December	1.994

2.1.3 Diesel Generator

The AC generator has a capacity of 40 Kw. Its initial cost is $20000 and replacement cost is $16000. The operation and maintance is$ 0.6 per hour. Its lifetime is estimated at 15000 operating hours. Other details of generator shown in Fig. 2.

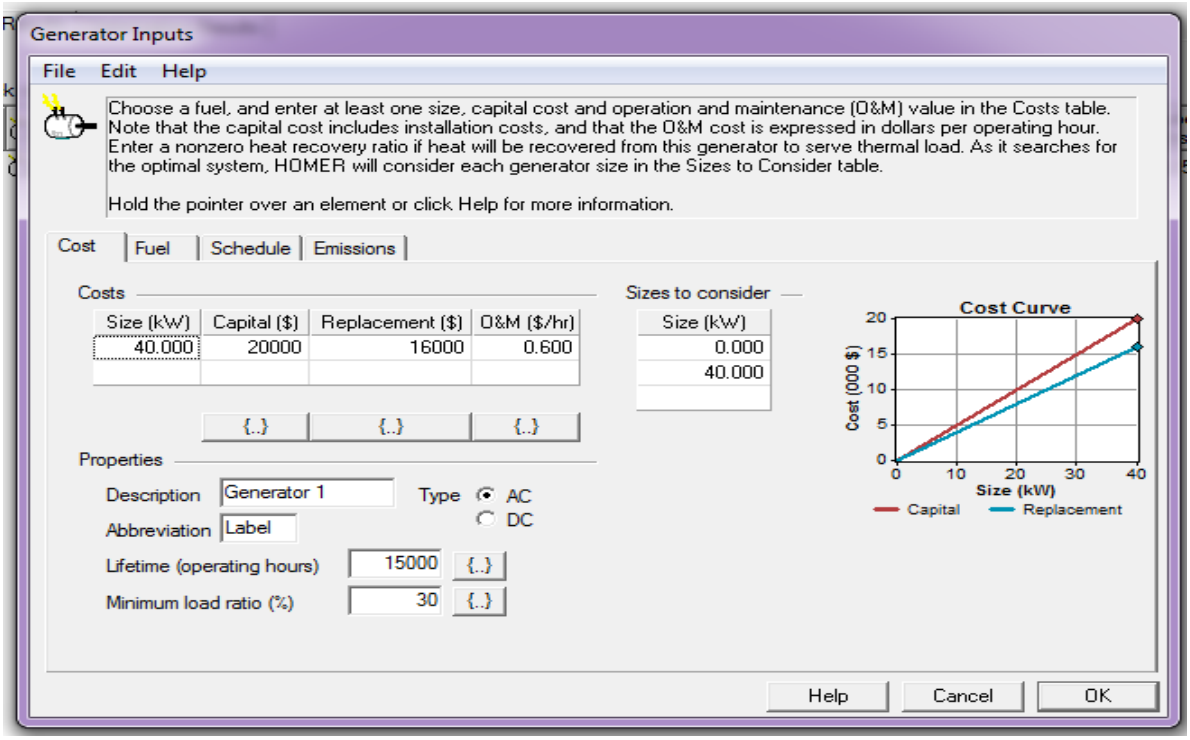

Figure 2. Diesel Generator Input

2.1.4 Battery and Converter

The Surrelte 4KS25P battery is rated at 4V and has a capacity 1900Ah. In this proposed system ten battries are used. Initial cost $2700 each and replacement cost $700 each. The maintance cost assumed to be $35 per hour.

3. RESULTS AND DISCUSSION

The optimization results of hybrid renewable energy system using HOMER are shown in figure 3. Solar photovotic system with battery, inverter and generator have the lowest total net present cost at $386.138 and cost of electricity of $1.096 per Kwh.

Table 4. Optimum solution hybrid renewable energy system

PV (KW)	Wind	Diesel Generator (KW)	Battery	Inverter (KW)	Initial Cost ($)	Total NPC ($)	COE ($/KWh)
8		40	8	10	92.600	386.138	1.096
8	1	40	8	10	94.700	389.576	1.106
		40	10	4	32.600	407.920	1.158
	1	40	10	4	34.700	411.270	1.167
10		40		6	95.400	615.305	1.747
10	1	40		6	97.500	618.656	1.756
		40			20.000	631.518	1.793
	1	40		4	25.700	640.202	1.817

For this combination if we goes towards the electricity produced by that system then it is observed that PV array produce 13131Kwh/Yr about 25% and generator produce 40200 Kwh/Yr about 75% of total . And consumption is about 27557Kwh/Yr so the 38.9% excess electricity is remaining with maximum renewable penetration of 1.434% shown in Fig. 3.

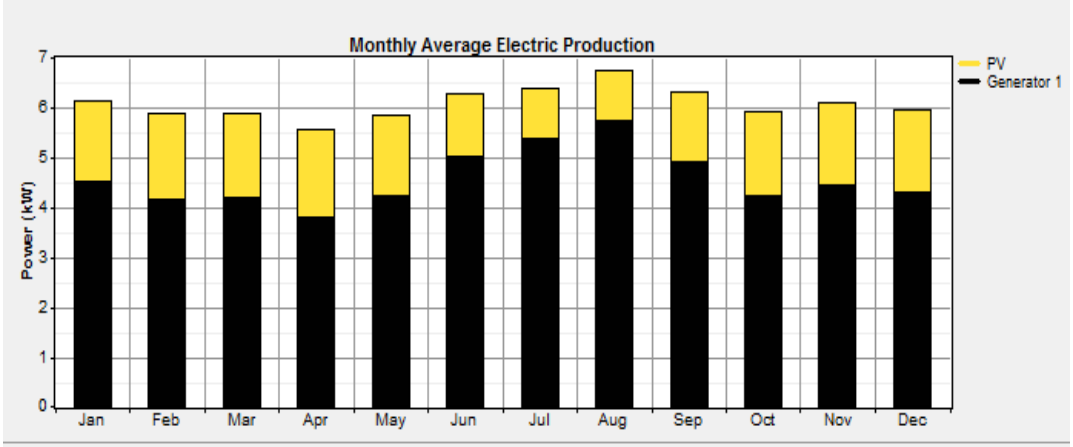

Figure 3. Electricity production by Solar PV Generator set

Another secand solution given by HOMER is solar PV wind system with battery, generator have total net present cost at $389.576 and cost of electricity of $1.106 per Kwh. The electricity produce by this combination is 53347Kwh/Yr out of this total 25% meet by solar PV, 0% by wind and 75% by generator set. From this it is clear that combination of solar wind system is not a fisible option concern with electricity production.

Table 5. Total Annualized Cost

Component	Annualized Capital Cost ($/Yr)	Replacement Cost ($/Yr)	Other & Maintence Cost ($/Yr)	Fuel Cost ($)	Total Cost ($/Yr)
PV	56000	17461	0	0	63675
Diesel Generator	20000	39111	25695	212407	295660
Battery	7600	5270	895	0	13469
Inverter	9000	3755	1278	0	13335
System	92600	65598	27868	212407	386138

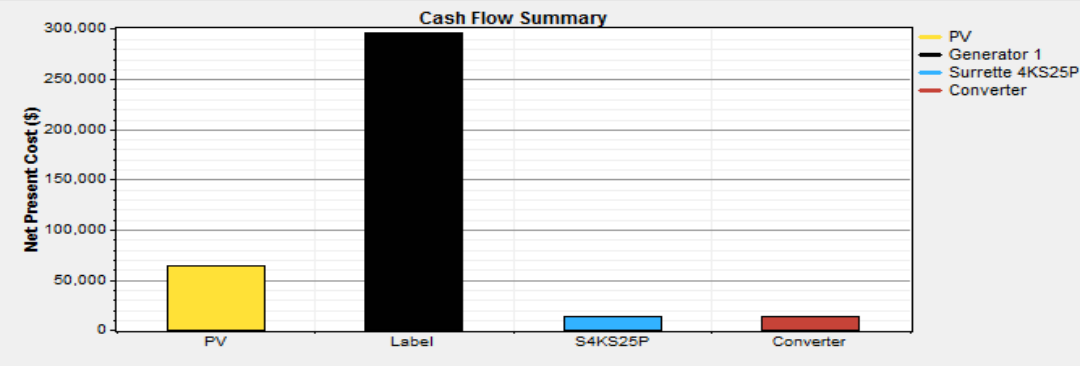

Figure 4. Cost summery of different components.

Figure 5 shows the annualized cost of the solar PV components. The solar PV contributes 16.50%, battery cost 3.48%, inverter cost 3.45% and generator largest at 76.56% of total annual cost of $386.138. The cost of generator plays an important part in determining the total net present cost and cost of electricity.

4. CONCLUSION

The result from simulation of integrated renewable sytem in HOMER shows that solar PV generator with battery and inverter is the most economical solution over PV- Wind with battery, to design integrated system with minimum total net present cost and cost of electricity. Comparision of optimization results of both the hybrid systems depicts that the first combination is economical. Though the different RESs are technically suitable and available in market, but not necessarily be financially viable. Hybrid design should be such that the component selection for electricity production must be economical. Economical viability should be in top priority over the technical feasibility exclusively for rural electrification in rural part of country like India as the end users have least pay capacity due to weaker economic status.

REFERENCE

[1] Kaldellis, J.K., Kondili, E. & Filios, A.," Sizing a Hybrid Wind-Diesel Stand-Alone System on the Basis of Minimum Long-Term Electricity Production Cost," *Applied Energy*, Vol.83, 2006, pp. 1384-1403.
[2] Kellog, W., Nehrir, M.H., Venkataramanan, G. & Gerez V," Optimal Unit Sizing for a Hybrid Wind/PhotovotaicGenerating System. Electric Power Systems Research," Vol 39, 1996, pp. 35-38.
[3] Borowy, B.S. & Salameh, Z.M., "Optimum Photovoltaic Array Size for a Hybrid Wind/PV System," *IEEE Transaction on Energy Conversion*, Vol. 9, No. 3, 1994, pp.482-488.
[4] Dufo-Lopez, R., & Bernal-Augustin, J.L., "Design and Control Strategies of PV-Diesel Systems Using Genetic Algorithm," *Solar Energy*, Vol. 79, 2005, pp. 33-46.
[5] Muselli, M., Notton, G., Poggi, P. & Louche, "A PV-Hybrid Power Systems Sizing Incorporating Battery Storage: An Analysis via Simulation Calculations," *Renewable Energy*, Vol. 20, 2000, pp. 1-7.
[6] Seeling-Hochmuth, G.C., "A combined optimisation concept for the design and operation strategy of hybrid-pv energy systems," *Solar Energy*, Vol. 61, No. 2, 1997, pp. 77-87.
[7] Seeling-Hochmuth, G.C., "*Optimisation of Hybrid Energy Systems Sizing and Operation Control*," PhD Thesis, University of Kassel, 1998.
[8] Koutroulis, E., Kolokotsa, D., Potirakis A. & Kalaitzakis, K., "Methodology for optimal sizing of stand-alone photovoltaic/wind-generator systems using genetic algorithms," *Solar Energy*, Vol. 80, No. 9, 2006, pp.1072-1088.
[9] Goldberg, D.E., "*Genetic Algorithms in Search, Optimization and Machine Learning*," Addison-Wesley, New York, 1989.
[10] Juhari Ab, Kamaruzzaman S, Yusoff Ali, "Optimization of Renewable energy Hybrid System by Minimizing Excess capacity," in International Journal of Energy, Vol. 1, 2007, pp. 77-81.
[11] Ashok, S., "Optimised model for community-based hybrid energy system," 32, 1155-1164, 2007.
[12] Paska, J., P. Biczel, and M. Klos, "Hybrid power systems – An effective way of utilising primary energy sources," Renewable Energy, 34, 2414 – 2421, 2009.
[13] Ekren, O., and B. Y. Ekren, "Size optimization of a PV/Wind hybrid energy conversion system with battergy storage using response surface methodology," Applied Energy, 85, 1086 – 1101, 2008.

BIBLIOGRAPHY OF AUTHORS

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