

Hybrid Energy System for a Rural Area

Shweta Goyal^{1*}, Sachin Mishra², Anamika Bhatia³, Puspender Singh Jarodia⁴

^{1,4}Department of Electrical Engineering

²School of Electronics and Electrical

Lovely Professional University, Jalandhar, Phagwara, Punjab, India

³Department of Electronics Engineering

^{1,3,4}Graphic Era Deemed to be University, Dehradun, India

^{1*}shwetugoyal@gmail.com, ²rite2sm@gmail.com, ³anamikajain2829@gmail.com

⁴pushpendraer@rediffmail.com

*Corresponding author

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Abstract

Nowadays, renewable energy has received significant research attention to reducing greenhouse effects as well as the cost of utilization of electrical power. A hybrid power station, i.e., a combination of renewable and convention power station could be a good substitute of a conventional plant to reduce global warming effects. In anywhere a remote situated area or boondocks may be recherché as a case study in a procedure to inquire the accomplishment to apply a hybrid power system and allow to the rural areas. The proposed Hybrid energy system is simulated in HOMER software. In HOMER software simulation has accomplishment and details of concern study are also described in this paper.

Keywords- Site Selection; Simulation; Result.

1. Introduction

In nature, the sources of renewable energy are available as solar, wind, and hydropower called renewable energy sources, we can generate the electrical energy from these types of sources for the lifetime. Ammar et al. (2011) said the hybrid power system is an organized system for various technologies including fossil fuels to generate the electrical power. These sources are often independent in nature for electrical power grids and using to distribute the electricity in rural areas. Nagasujatha et al. (2015) showed the new technologies in hybrid power system and talked about the excellent performance, environmental benefits low running cost compared with a diesel generator of the system. Another advantage of the hybrid power system is to expend the generation of electrical power capacity to fulfill the future demand and transmit to the grid. Because the basic thing is to provide the sufficient power to the rural area as per required demand. Therefore, hybrid power system is the splendid strategy to fight this problem of energy in rural villages. This system gives the facility to generate the electrical power by using any one renewable energy sources e.g. solar or wind or by the combination of both. In India there are many rural villages to generate the power by using the desirable combination of power sources in hill area as Uttarakhand and

Himachal Pradesh, those can be select for investigation after case-study.

Delvecchio et al. (2005) shows hybrid energy systems often unified non-conventional energy sources with paleontological and traditional diesel/petrol based generators provide electrical power and can acting as Back-up in case of lack of the primary source. Hybrid energy system it is very much possible for a particular energy source to provide the different percentage of entire load. At the situation of the cloudy and windy day, when solar panel was generating low energy power than wind generator is able to make up the generating large electricity. Here two admissible hybrid power methodology was shown. Primarily Diesel generators based system for reduced of diesel intake using renewable energy sources Shaahid and Elhadidy (2007) gave an economic analysis on a hybrid energy system for hot regions.

A proposed hybrid energy system is shown in Figure 1, it has the capability to provide 24-hour grid quality electricity to load. In the compression of diesel generator groundwork, these types of schemes provide the best functioning, flexibleness to planning and environmental advantages.

The advantage of using non-conventional energy sources are low fuel uses, decreasing the operational and maintenance cost and cultivate the operational performance in the distant area. Often at these types of locations, the fuel cost including transport is very precious. Further, in India, the climate change is a big issue for a generation of power by the renewable power plant. Setiawan and Nayar (2006) said the major demerit of the renewable power station is variation in availability of renewable energy during seasonal fluctuations because of this is the reason for very difficulties to achieve the good result and full the load demand. Mohamed et al. (2008) told that the high load demand or low generation from renewable sources use the diesel generator for backup.

2. Site Selection

2.1 Adoption of Villages

Dudhali village is selected for this study, located at 30.232110N, 78.014992S in Uttrakhand state. Table 1 gives the details of the village. The adjacent town is Mussoorie, which is about 16-19 km away. Dudhali located nearly cloud end area in Mussoorie. The village has hilly area and does not have transportation facility.

2.2 Village Load Assessment

The main motive for this field of study was the selection of village in a distant area to study the probability of using hybrid power system to fulfill the required supply power for the desired load of the village for the whole year. According to study village needs around 70 kW peak and 500 KW/day. Graph of load profile shown in Figure 1.

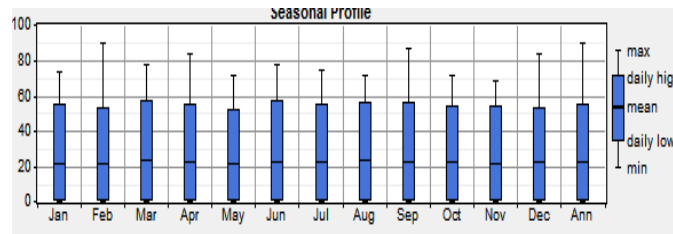


Figure 1. Annual load profile for this village

2.3 Resource Estimation

The major thing is to consider that the village is without power grid and the second purpose is if this village will be totally reckoned on the hybrid power system difference impact could be seen here. For the selected village, the non-conventional energy sources e.g. the information about solar is given in Table 1 taken from NASA website.

The main component of a power system is generation, transmission, distribution system. In this study, the solar cell used as a primary source while diesel generator as a secondary source, Batteries for store the excess electricity and Converter for converting DC to AC. The main factor of the analysis is a Cost of Energy (COE) and NET Present Cost (NPC). solar insolation is better in given location so that the maximum power is generated by the solar system. The capital cost and replacement cost is taken \$750 & \$238 respectively for 1 w solar cell, only \$11/year is taken for O & M costs for 20 years of lifetime. The de-rating factor is 80%. 50 w, 100 w and 150 w solar panel used in search space to find out a best suited result.

A 4 V Surrerte 4KS25P at 1900 Ah (6.94 kWh) power battery and a 3 kW generator used as support system when the renewable source is not present costs for generators are: \$338, \$300 & \$. 38/year Cost, replacement, and the maintenance cost respectively. And for batteries are \$1000, is \$800 and \$50/year.

Table 1. The solar radiation and wind speed readings for the village

Months	Clearness Index	Daily Radiation	Months	Clearness Index	Daily Radiation
January	0.620	3.571	July	0.519	5.837
February	0.627	4.391	August	0.537	5.837
March	0.627	5.429	September	0.537	5.837
April	0.637	6.479	October	0.623	5.625
May	0.653	7.258	November	0.707	5.698
Average	0.617		5.345		

3. Simulation of Hybrid Power System

First to design a mini stand-alone hybrid power station, select the site where is to be providing the data. Kind of data or information required are: the load visibility must be met through the system, solar lights for photo volatile modules to generate the electricity, primary value for each element as diesel generator, non-conventional energy generator, storage battery, converter, wires, installation prices, price of diesel, annual interest rate, lifespan project and annual maintenance cost etc. By applied this information can be performed the simulation to the find best hybrid power station configuration. HOMER is one of the tools to execute this objective. Shown in Figure 2.

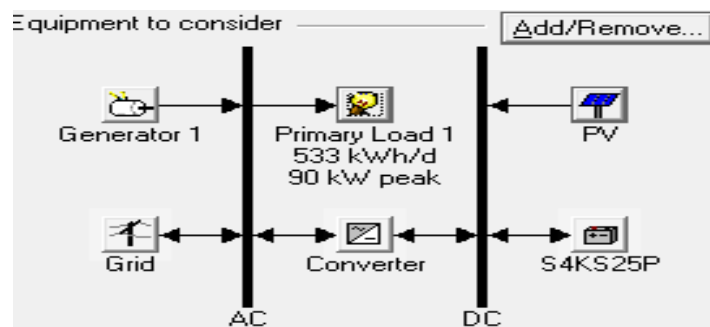


Figure 2. Hybrid energy system proposed in homer

4. Results

We get different configuration with different component result which is shown in Table 2. But the best result configuration get is I model.

Table 2. Four different configurations with different component

System Component	Availability			
	I Model	II Model	III Model	IV Model
Solar Photovoltaic	Yes	Yes	Yes	Yes
Battery	Yes	No	Yes	No
Generator	No	No	Yes	Yes

It is seen that when using all four component then NPC (Net Present Cost) of \$286,530 and COE (Cost of Energy) \$0.179/kWh which is the best configuration with moderate production. Table 3 shows the electricity production by different apparatus from I configuration and

Figure 3 and 4 shows the monthly standard power generation and cash flow review respectively.

Table 3. Power generations by different apparatus

Production	KW/yr	%
PV array	166,345	91
Generator 1	15,677	9
Total	182,022	100

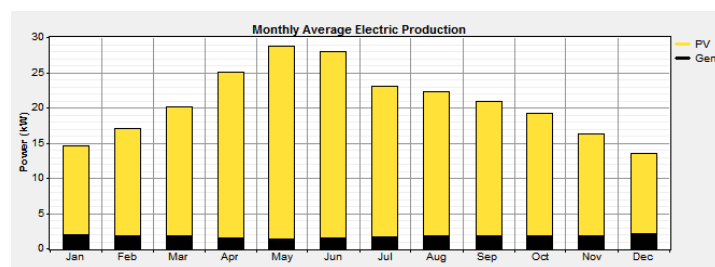


Figure 3. Average production graph

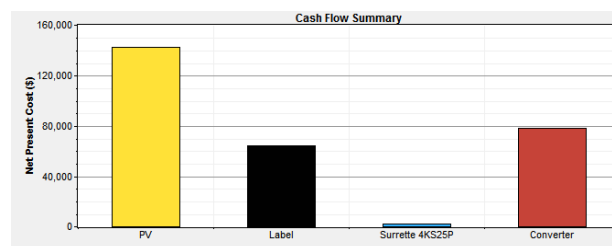


Figure 4. Cash flow summary for configuration 1

5. Conclusions

Table 4 shows the comparative study of different configurations in homer with step time 50 and optimized completed in 1.34 min the job had been done on HRES for Dehradun Block using solar/diesel/battery/converter apparatus and found the best-suited hybrid model for the selected block, By which we can found the lowest NPC, COE, operating cost.

Table 4. Comparative study between different configurations

S. No.	Configurations	Total energy production KWh/yr	NPC(\$)	COE(\$)/KWh	OPERATING COST(\$)/yr
1	SPV /battery/ diesel generator	182,002	286,530	0.0179	13,509
2	SPV /diesel generator without battery	182,211	285,174	0.179	13,481
3	SPV /battery diesel generator without	249,518	293,280	0.187	11,130
4	SPV without diesel generator and battery	249,518	291,216	0.187	11,047

The optimization and simulation show that on the basis of reasonable COE and NPC, i.e. with the entire four components we get the best alternative but meet maximum consistency.

- I model has the maximum renewable incursion.
- II model consists of SPV/diesel but the battery has lowest NPC. But there is no backup in the system. If somehow any source is not present then we will not able to get electricity. With the comparison of model 1, it reduces the initial cost But meet higher operating.
- In III model without diesel generator has the same problem as II model.
- In IV model without battery and diesel does not have any storage system and back system for excessive battery. Which will increase operating cost so NPC and COE also increase.

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