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OPTIMIZATION OF STANDALONE HYBRID RENEWABLE ENERGY MODEL

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ABSTRACT

In this paper, authors Proposed a optimal design of standalone Hybrid Renewable Energy Model (SHREM) for electrical load requirement of organization (IPS Academy, IES, Wing –A), Indore. The HREM consist the Diesel generator set, Solar Panel, Wind Turbine, and Storage system to fulfill electrical load requirements of IPS academy Indore. In this study considered a hybrid energy model feeding AC primary load 2524kWh/day (scaled average) and energy consumption with 450kW maximum load demand. Proposed Hybrid energy model is optimized cost of energy INR Rs.6.99/kwh which is verified by simulation result. HOMER Pro is analyzed the sizing, cost optimization and control strategy of proposed hybrid energy model. In this work, the computation, simulation & optimization of HREM are done by using HOMER Pro Software.

Keywords: SHREM, HOMER Pro, Optimal Design, Hybrid Energy Model, Simulation & Optimization.

I. INTRODUCTION

The fossil resources of energy such as coal and natural gas will eventually be finished and pollution problem caused by fossil resources increasing day by day. These are the major drawback factor to use renewable energy recourses [1]. Renewable energy recourses are not able to fulfill the load demand every time; therefore hybrid energy system is use [2]. A hybrid energy model generally consists of two or more than two renewable energy sources with energy storage components. It is used together to provide increased system efficiency as well as balance in electrical energy supply [3]. Hybrid Energy model is developed for cost optimization of energy meets to 450kW maximum load demand of IPS Academy Indore. A Hybrid energy model is a system that generates electricity to serve a nearby load. Such a system may employ any combination of electrical generation and storage technologies and may be on grid or off grid. Some examples of Hybrid energy model are a solar, wind, diesel system and battery system serving a remote load. HOMER pro software can model grid-connected and off-grid systems serving electric and thermal loads, and consisting any combination of solar panels, wind turbines, small hydro, biomass power, fuel cells, batteries, and hydrogen storage. The analysis and design of Hybrid energy systems can be challenging, due to the large number of combinations and the uncertainty in load size and future fuel price. Renewable sources add further complexity because their power output may be intermittent, seasonal, and the availability of renewable resources may be uncertain.

About HOMER Pro Software

HOMER is an abbreviation of a Hybrid Optimization Model for Electrical Renewable and it is developed by National Renewable energy Laboratory (NREL) [4]. HOMER Pro allows simulation of grid-connected and off-grid system which generate electricity from various combination of solar PV modules, wind turbines, biomass based power generator, fuel cells, batteries, and hydrogen storage and different types of loads.

II. METHODOLOGY

The standard /or most efficient working hours for an organization is 8 hours. The basic load is required to use electrical appliances like tube light, ceiling fan, air conditioned, lift, computers, and machinery. The energy load demands in the morning and night hour are small load but demand to 8 hours from 9:00 to 5:00 approximant high as compared morning and night hour. On an average for this study 2200 kWh/day or 358kW/day has been considered to scale load. In this study author used HOMER Pro Software for calculation, analysis and simulation shown in Figure 1.

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Figure 1: HOMER Pro Software system architecture

III. MODELING AND ANALYSIS

Modeling of hybrid energy system for optimize cost of energy is developed a model by using HOMER Pro software. In this model, firstly consider AC primary load of IPS Academy Indore and know about maximum demand. Load profile of ac load help to determine 2200 kWh/day (scaled average) and maximum demand (450KW). On the basis of that analysis is developed a modeling of hybrid energy system for cost optimization of energy. The model has been designed HOMER Pro software, and consists of Diesel Generator sets, Solar panels, Wind turbines, Converters and Battery Storages the schematic of this hybrid energy system model is shown in Figure1.

Table 1. PV- Wind-Diesel Microgrid /Standalone Hybrid system

Component	Name	Size
Generator	Generic Large Gen set (size-your-own)	144 kW
PV	Generic flat plate PV	804 kW
Storage	Generic 1kwh Lead Acid	2542 Strings
Wind turbine	Generic 10 kW	1 ea
System converter	System converter	303 kW
Dispatch strategy	HOMER Cycle Charging	

1. Graph between AC Primary Load, Unmet Load and AC Primary Load Served (Yearly):

The entire document should be in Times New Roman or Times font. Type 3 fonts must not be used. Other font types may be used if needed for special purposes.

Recommended font sizes are shown in Table 1. In below figure 3 shows the Graph between AC Primary Load, Unmet Load and AC Primary Load served (Yearly) is obtained using HOMER software. In graph there is ac primary load shown by blue bar lines and ac load served by solar pv, wind and diesel hybrid system is shown by green bar lines. By observing primary load demand and primary load served by hybrid system graph there is a 100% similarities in both graphs. This means that ac load demand is totally served by hybrid system and there is no unmet load in whole year i.e. unmet load is zero depicted in graph by red line.

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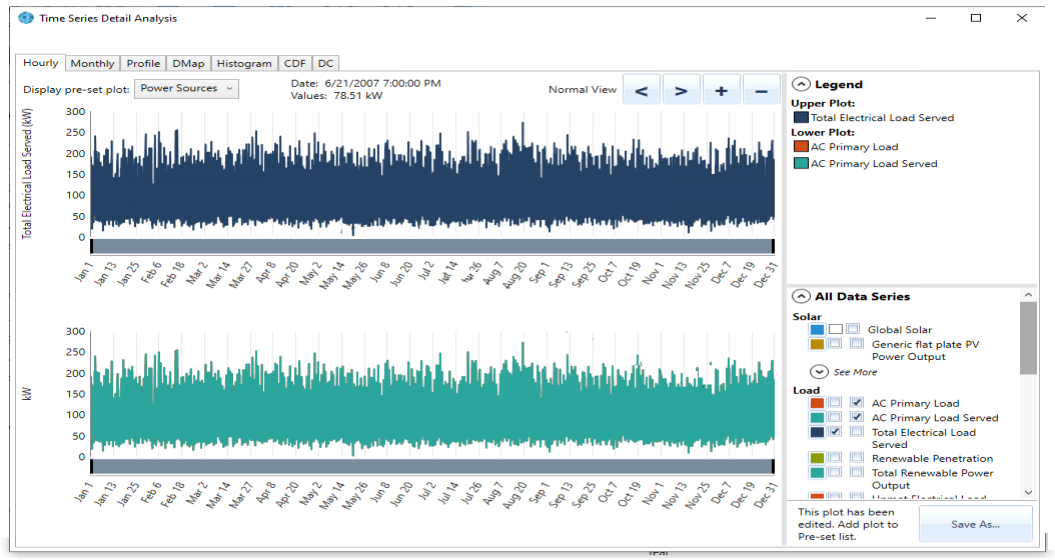

Figure 2: Graph between AC Primary Load, Unmet Load and AC Primary Load served

2. Graph between AC Primary Load and PV, Wind Mill and DG Set Hybrid System Output Power (Yearly):

In below figure 4 shows the Graph between AC Primary Load and PV, wind mill and DG set hybrid system output Power (Yearly) is obtained using HOMER software. In graph there is ac primary load shown by blue bar lines and Solar PV panel output power contribution shown by yellow bar lines, Wind mill output power contribution shown by green bar lines and DG output power contribution shown by black bar lines. Contribution of individual energy system to serve the AC primary load demand is depicted in graph given below.

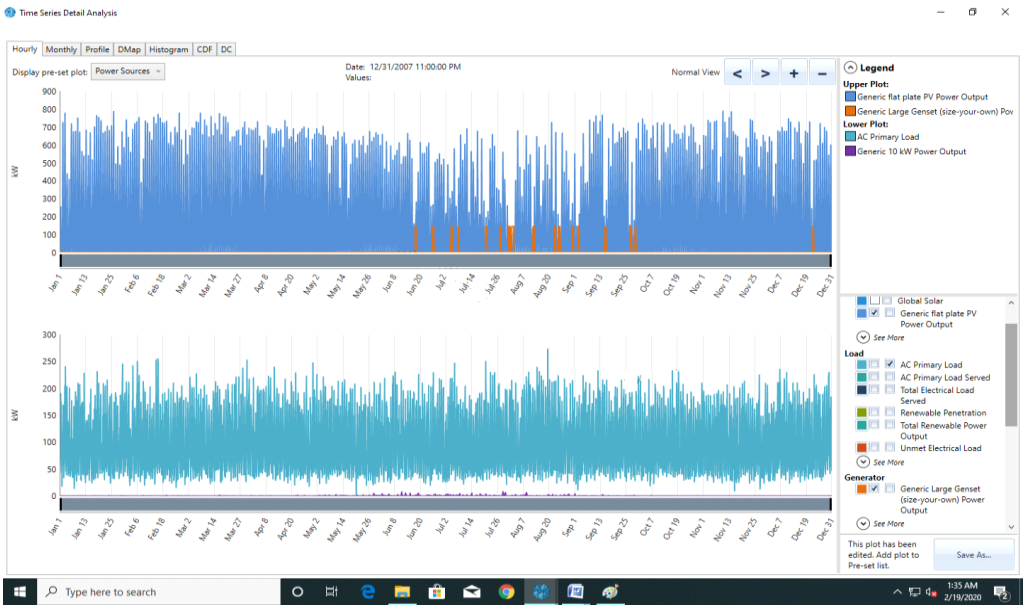

Figure 3: Graph between AC Primary Load and PV, wind mill and DG set hybrid system output Power

IV. RESULTS AND DISCUSSION

The following table shows the detailed optimization results of the mentioned study using HOMER Pre Software. Total energy generated by PV panel, wind generator & diesel generator is represented in KW. The total capital cost, operating & maintenance cost is in Indian rupee. Operating cost is calculated as INR/KWh. Electrical production is mention as KWh.

Table 2. Comparison of different Cases

S No.	P.V.	Wind.	D.G.	Battery	Converter	Total Capital Cost	Total Operating and Maintenance Cost	Operating Cost	Cost of Energy	Electrical Production	Capacity Shortage
	(KW)	**(KW)**	**(KW)**	**(No.)**	**(KW)**	**(RS)**	**(Rs)**	**(Rs/Yr.)**	**(Rs/KWh)**	**(KWh.)**	**(KWh/Yr.)**
1	804	1	144	2542	303	114M	544000	2.42M	6.99	36757	0
2	806	1	144	2523	307	114M	542000	2.42M	6.99	36609	0
3	801	1	144	2552	305	114M	546000	2.43M	6.99	36999	0
4	812		144	2526	383	114M	536000	2.41M	6.99	36151	0
5	802	1	144	2537	302	114M	548000	2.43M	6.99	37066	0
6	813		144	2525	380	114M	536000	2.41M	7.00	36199	0
7	815		144	2530	305	114M	540000	2.41M	7.00	36391	0
8	809		144	2533	283	114M	552000	2.44M	7.00	36977	0
9	805		144	2547	305	114M	554000	2.45M	7.00	37439	0
10	798	1	144	2566	301	114M	552000	2.45M	7.00	37161	0
11	817		144	2512	382	114M	534000	2.40M	7.00	36043	0
12	809		144	2551	300	114M	552000	2.44M	7.00	37034	0
13	826	2	144	2530	314	114M	514000	2.35M	7.00	34613	0
14	807	1	144	2524	386	114M	542000	2.42M	7.01	36592	0
15	824	1	144	2499	309	114M	526000	2.38M	7.01	35439	0
16	798	2	144	2544	310	114M	552000	2.44M	7.01	37257	0
17	803	1	144	2531	382	114M	548000	2.44M	7.01	37072	0
18	830		144	2520	382	114M	520000	2.37M	7.01	34968	0
19	797	1	144	2555	305	114M	560000	2.46M	7.01	37834	0
20	857		144	2503	304	114M	734000	2.30M	7.01	18851	0
21	807	1	144	2545	311	114M	550000	2.43M	7.01	36999	0
22	829		144	2481	307	114M	802000	2.39M	7.01	20620	0
23	808	1	144	2550	301	114M	548000	2.43M	7.01	36822	0
24	835	1	144	2528	307	114M	512000	2.35M	7.01	34557	0
25	842		144	2480	312	114M	776000	2.35M	7.02	19907	0
26	856		144	2523	305	114M	728000	2.30M	7.02	18710	0
27	817		144	2485	303	114M	826000	2.43M	7.02	21308	0
28	810	1	144	2536	305	114M	548000	2.43M	7.02	36822	0
29	861		144	2506	301	114M	728000	2.29M	7.02	18614	0
30	848		144	2464	301	114M	770000	2.34M	7.02	19739	0

V. CONCLUSION

In this paper, a hybrid energy model is developed for cost optimization of energy by use of HOMER Software. Conclusion of this work, we have simulated to propose hybrid energy model and got simulated results. Simulated results are analyzed and their details are mentioned: 16 no. of PV panel, 01 no. of wind mills(10 KW), 01 no. of 144KW D.G. set, 2542 no. battery of 1kWh Lead Acid, 02 no. of 150KW converters are required for hybrid system model. Total capital cost is □ 64.5M, total operating & maintenance cost is □ 12.0M. Optimized cost of energy corresponding to the hybrid system model is 6.99□ /kWh and total electrical energy production is 1475851 KWh/Yr by the hybrid standalone system.

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