A NOVEL SYSTEM OPTIMIZATION OF A GRID INDEPENDENT HYBRID RENEWABLE ENERGY SYSTEM FOR TELECOM BASE STATION

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ABSTRACT

Hybrid renewable energy based off-grid or distribute power supply has customarily thought to be a solitary innovation based restricted level of supply to meet the essential needs, without considering dependable energy procurement to rural or remote commercial enterprises. The aim of the paper is to propose a design idea off-grid hybrid system to fulfil the load demand of the telecom base station by using renewable energy resources for rural regions. HOMER software tool is used for simulation and optimization and it also analysis the total net present cost (TNPC) \$100,757, carbon emission is zero percent, initial cost \$70,920, operating cost \$2,334, Capacity Shortage 0.17% and the cost of energy (COE) \$0.502. The HOMER simulation outcome gives the most feasible hybrid system configuration for electric power supply to the remote location telecom base station.

KEYWORD

Solar-PV, wind turbine, hybrid system, Base transceiver stations, Homer.

1.INTRODUCTION

Getting reliable along with economical power solutions for the world-wide enlargement associated with telecommunications into rural remote and rural provides an very tough issue. The Indian telecom industry is one of the most effective, increasing industries on the globe [1]. The Indian subcontinent is now incorporating 8–10 thousand cell buyers every 4 weeks. The power fears regarding India's phone system sector, particularly from the non-urban places are quite evident. This is a large concern for your business to fulfill its regular electrical power needs via regular fuel, and that is high-priced. Power deficits coupled with the growing price of diesel pose a substantial challenge to the medium-term growth and profitability of the telecom sector. Continued reliance on diesel will also substantially increase the environmental costs in the form of carbon emission. The telecommunication industry is able in order to transit to your business structure that relies on power efficiency standards in combination with harnessing clean up power resources to its concerns. It's compelling the industry to catch out for substitute green power solutions. Hence, India's increasing telecom tower system market can do large benefits, whilst decreasing his or her conventional-fuel reliance and co2 and path, by using hybrid renewable energy sources for force generation. Various Alternative energy Resources, for example, solar energy, wind power, biomass, etc. utilized with respect to telecom apps in developing international locations. Numerous literature references include talks about the particular economic cost examination involving permutations involving hybrid electric power method [2-4]. Likewise,

there is a considerable measure of literature about configuration and the investigation in the setting of renewable energy power generation [5-7]. The primary purpose of this theme is to design hybrid renewable energy systems by using the HOMER software tool in all aspects like best possible cost allocation of each individual elements present in the solar system, radiation, wind velocity, carbon emission and power generation [11]. Investigation with HOMER obliges data on assets, economic limitations, and control scheme. It likewise obliges inputs on part sorts, their numbers, expenses, effectiveness, life span, and thus onward. The proposed hybrid system model shown in fig. 1. Sensitivity investigation might be possible with variables having a scope of qualities rather than a particular number. [8] For proposed hybrid renewable energy system the meteorological information on sun oriented radiation and wind speed is taken from the village, Palari in the state of Chhattisgarh, India with Latitude 19_6350N and Longitude 81_672E and load profile for telecom are superbly modelled [9].

Fig.1 Proposed hybrid system model

2.DESIGN OF THE HYBRID SYSTEM

Hybrid Optimization Model for Electric Renewable (HOMER) software assists us to decide how distinctive renewable, and hybrid frameworks communicate with end-utilization demand. In light of the accessibility and capability of renewable energies in the specific territory a hybrid energy framework is designed.

2.1Laod profile

The Base Transceiver Station-BTS load is considered as essential load. The BTS is a telecom base used to encourage remote correspondence between supporter gadget and telecoms administrator system. The worldwide advancement of BTS is progressively occurring in areas in which the power conveyance framework regularly separates for drawn out stretches of time or where there is no entrance to the power supply system. So the BTS in such area, diesel generators with batteries are utilized to move down the network for power supply and guarantee system accessibility. Yet these oblige an abnormal state of support work and devour moderately high measures of diesel fuel for low-level yields. Accordingly diesel generators acquire high working costs. The developing cost of energy because of increasing diesel costs and concerns over getting bigger greenhouse production have created the telecom organizations to concentrate on better power administration routines. The present power supply scheme for grid connected and diesel generator telecom base station is pictured in fig. 2. This system delivers very high operating cost due to heavy reliance on diesel generator and worse performance of batteries [12].

Fig.2 Grid connected and diesel generator telecom base station

In this proposed system telecom base station considered load taken as 50kWh/d and peak load of day is 4.4kW. The information was measured for the aggregate hourly premise every day load prerequisite of a rustic telecom. Daily, hourly load data as shown in fig. 3.

Fig.3 Telecom load profile

2.2Solar model

The solar resource used for proposed hybrid power system at a location of 19_590N latitude and 81_590E longitude was taken from the NASA Surface Meteorology. The time zone is GMT+5:30 India. The annual average solar irradiation and the average clearness index were found to be 4.99kWh/m²/Day and 0.530 respectively. The particular photovoltaic radiation is available whole year round; thus a large deal of photovoltaic energy productivity can be obtained it is depicted in fig. 4. In rainy season clearness index and solar power availability are lower than summer and winter season. The maximum solar power obtains in summer season.

A 5kW solar photovoltaic (SPV) array is connected in series parallel with the proposed hybrid system. At the point when the sunrays strike the SPV panels, it delivers power. For proposed hybrid system, installation cost and replacement cost are \$5000 and \$3000 of the 1kW solar panel. The SPV connected to DC link and the de-rating factor of the array is 80% and the lifetime span of the SPV arrays is taken as 20 years and no tracking system is included in the PV. Slope, ground reflectance in percentage and azimuth (Degrees W to E) are 19.9833, 20 and 0 respectively. The SPV cost curve shows in fig. 5 and weather data of the proposed hybrid system location shown in table no.1.

Fig.4 Global horizontal radiation and clearness Index.

Fig.5 SPV Cost curve

S. No	Month	Clearness Index	Daily Radiation (kWh/m²/d)
1	January	0.658	4.930
2	February	0.674	5.710
3	March	0.648	6.250
4	April	0.628	6.610
5	May	0.589	6.420
6	June	0.410	4.500
7	July	0.319	3.480
8	August	0.317	3.360
9	September	0.426	4.220
10	October	0.556	4.890
11	November	0.637	4.900
12	December	0.661	4.730
13	Average	0.530	4.994

Table 1. Monthly solar resource of the site

2.3 Wind turbine

Wind energy resource, a monthly average wind speed data collected from village Palari, sub district Kondagaon, district Bastar, state Chhattisgarh, India. This is shown in fig.6 shown average wind speed data throughout the year [8]. The time step is 60 minutes, Weibull K (A measure of the long-term distribution of wind speeds) is 2, hour of peak wind speed (The time of day that tends to be windiest on average) 15, Diurnal pattern strength (A measure of how strongly the wind speed depends on the time of day) 0.25 and 1 hour autocorrelation factor (A measure of the hour-to-hour randomness of the wind speed) is 85.

Fig.6 Wind resource data

BWC Excel-R (XLR) turbine is used in the proposed hybrid system. Accessibility of energy from the wind turbine depends incredibly on wind variation. In this manner, the wind turbine rating is by and large much higher contrasted with the normal electrical load. In this investigation, Wind Power's XLR model is considered. The lifespan of a turbine is taken to be 20 years. The rated capacity of this turbine 7.5kW DC. The installation cost, replacement and maintenance cost of this turbine are \$1500, \$1200 and \$75 respectively. In fig.7 and fig. 8 shows the cost curve and wind variation with height.

Fig.7 cost curve of wind turbine

Fig.8 wind speed profile

2.4Generator

1kW generator is considered for hybrid system. The capital cost, replacement cost and operating-maintenance cost of the generator is \$325, \$225 and \$0.520 respectively. Fuel used for generator is diesel and the cost of diesel is varying according to international market rate. The Diesel price is used for sensitivity analysis and different values of diesel fuel price are 0.8\$/L, 0.85\$/L, and 0.89 \$/L was introduced. The lifespan of generator is taken as 15,000 operating hours. HOMER ascertains the aggregate working rate of the generator in view of the measure of time it has to be utilized as a part of a year. The minimum load ratio (The minimum allowable load on the generator, as a percentage of its rated capacity) is 30%. Intercept Coefficient (the no-load fuel consumption of the generator divided by its rated capacity) is 0.08 L/hr/kW_{rated} and the slope (marginal fuel consumption of the generator) is 0.25L/hr/kW/output. The generator is connected to the AC side of the HOMER design model and size for the feasible optimal system are 1kW,2kW,5kW and 10kW considered. The cost curve and relation between efficiency and output of the generator it is shown in fig. 9 (a), (b).

Fig.9(a) Cost curve of generator.

Fig.9(b) Generator efficiency curve

2.5Battery

The proposed system is off-grid one so that a battery bank is used for a back-up system and which also maintains constant voltage cross the load. The vision 6FM200D battery is used for the optimum hybrid system. It consists 12V, 200Ah, and 2.4kWh, lifespan throughput is 917kWh and connected in series/parallel configuration. Capital cost, replacement cost and operating-maintenance cost is \$200, 195\$ and \$5 respectively. Battery bank state of charge and cost curve shown in fig.10 (a), (b) and relations between capacity and discharge of current shown in fig. 11.

Fig.10(a) Battery bank state of charge

Fig.10(b) cost curve of battery

Fig.11 Battery capacity vs discharge current

2.6 Converter

The SPV array output DC at a voltage, which relies on upon the particular configuration and the sun oriented radiation. The DC control, then races to an inverter, which changes over it into standard AC voltage. Inverters regularly utilized as a part of extensive scale applications are main inverters that offer simple establishment and high effectiveness. The size of the converter is depend on input direct current (DC) power of the SPV and output power of alternating current (AC) connected to the grid. The proper size of inverter has proficient to take the maximum power from the SPV and also reduce the cost of the inverter without disturbing the operation of the system. Inverter parameter shown in table no. 3 and the inverter cost curve in fig. 12.

Fig.12 converter cost curve.

Inverter data	
Lifetime	15 yr
Efficiency	90%
Capital cost per kW	\$ 620
Replacement cost per kW	\$ 330
O & M cost per kW per year	\$ 0

Table 2 Inverter data.

3.RESULTS AND DISCUSSION

In this paper, the proposed hybrid system fulfil the electric demand from the base transceiver station. In this hybrid system, solar irradiation, wind speed, diesel price, and battery cost are taken for sensitive analysis. For each of the affectability qualities recreate all the frameworks in their particular An hourly time arrangement simulation for each conceivable framework sort and design are finished a 1-year period. An ideal framework is characterized as an answer for combination framework setup that is equipped for taking care of the load demand of a base transceiver station.

According to simulation result obtained form HOMER software, the establishment of wind, solar phototovolatiac hybrid framework design for different areas are most suitable energy solution for base transceiver station organize in Indian destinations. From the final outcome of optimization results the most feasible combination of the hybrid system element are five SPV, two wind turbine, fourtty batteries and six converter. This system configuration has minimum installation cost and has maximum output at lowest cost of energy without using diesel generator set. This system has total net present cost (cost of installation plus opreting cost) \$100,757. Operating cost and cost of energy is 2334\$/yr, 0.502\$/kWh. It shown in fig.13. In this simulation grades remove all infeasible blends and positions the achievable frameworks as indicated by expanding net present cost. In fig.14 shown the Annual electricity production by different hybrid system by month. This optimal hybrid system combination provides 100% power supply to base transceiver station in which part of SPV 34% and part of wind turbines 66%.

	PV (kW)	XLR	Label (kW)	6FM200D	Conv. (kW)	Initial Capital	Operating Cost (\$/yr)	Total NPC	COE (\$/kWh)	Ren. Frac.	Capacity Shortage	Diesel (L)	Label (hrs)
	5	2		40	6	\$ 70,920	2,334	\$ 100,757	0.502	1.00	0.17		
	10	1		20	6	\$ 74,820	2,227	\$ 103,282	0.527	1.00	0.20		
	5	2		50	6	\$ 73,720	2,374	\$ 104,064	0.509	1.00	0.15		
	5	2		40	12	\$ 74,640	2,387	\$ 105,149	0.524	1.00	0.17		
	5	2		60	6	\$ 76,520	2,408	\$ 107,305	0.517	1.00	0.14		
	10	1		20	12	\$ 78,540	2,279	\$ 107,675	0.549	1.00	0.20		
	10	1		30	6	\$ 77,620	2,382	\$ 108,073	0.526	1.00	0.15		
	5	2		50	12	\$ 77,440	2,426	\$ 108,456	0.530	1.00	0.15		
	5	2		70	6	\$ 79,320	2,410	\$ 110,123	0.525	1.00	0.12		
	5	1	1	40	6	\$ 55,745	4,308	\$ 110,810	0.544	0.80	0.17	1,073	3,576
	10	1		40	6	\$ 80,420	2,437	\$ 111,578	0.532	1.00	0.12		
	5	2		60	12	\$ 80,240	2,461	\$ 111,698	0.538	1.00	0.14		
	10	1		30	12	\$ 81,340	2,435	\$ 112,465	0.548	1.00	0.15		
	5	1	1	50	6	\$ 58,545	4,250	\$ 112,871	0.553	0.81	0.17	1,053	3,509
	5	2		80	6	\$ 82,120	2,426	\$ 113,130	0.535	1.00	0.11		
	1	2	1	50	6	\$ 54,045	4,622	\$ 113,134	0.556	0.80	0.18	1,062	3,479
	5	2		70	12	\$ 83,040	2,462	\$ 114,515	0.546	1.00	0.12		
	10	1		50	6	\$ 83,220	2,452	\$ 114,567	0.540	1.00	0.11		
	1	2	1	60	6	\$ 56,845	4,541	\$ 114,899	0.561	0.81	0.17	1,018	3,334
	5	1	1	40	12	\$ 59,465	4,360	\$ 115,203	0.566	0.80	0.17	1,073	3,576
	10	1		40	12	\$ 84,140	2,490	\$ 115,970	0.553	1.00	0.12		
	5	1	1	60	6	\$ 61,345	4,281	\$ 116,072	0.568	0.81	0.17	1,043	3,474
	5	2	1	30	6	\$ 68,445	3,776	\$ 116,714	0.538	0.90	0.09	591	1,976
	5	2	1	20	6	\$ 65,645	4,008	\$ 116,881	0.548	0.87	0.11	731	2,456
	5	1	1	50	12	\$ 62,265	4,302	\$ 117,263	0.574	0.81	0.17	1,053	3,509
	10	1		60	6	\$ 86,020	2,445	\$ 117,276	0.548	1.00	0.10		

Fig.13. Optimization results of hybrid energy system

Fig.13 Annual electricity production by different hybrid renewable energy system

4.CONCLUSION

Because of the enduring development of Telecom market and related commercial enterprises in India, there is a need to build up another generation DC Power Supplies. Without a doubt the offer of telecom development in country ranges is much higher than metros. A self-sufficient energy framework consolidating renewable energy sources, and batteries as a storage medium was concentrated on. This paper shows where sun powered, wind assets are accessible; sending of solar based, wind can suitably address energy issue of inaccessible Base Transceiver Station. According to HOMER simulation results, the combination of SPV-wind turbine-battery can be most feasible solution as this type of hybrid system has no harmful gasses emission as Carbon dioxide 0, Carbon monoxide 0, Unburned hydrocarbons 0, Particulate matter 0, Sulfur dioxide 0 and Nitrogen oxide 0. The proposed system is more environment- pleasant. The surplus power can be stored in the battery and utilized for future utilization. The expense is likewise tolerably less. Solar radiation and wind are accessible openly and in this manner has all the earmark of being a guaranteeing innovation to give dependable power supply in the remote regions of India. This proposed hybrid system provides 100% supply by renewable energy sources (SPV-wind turbine) without using a diesel generator set and additional the off grid hybrid system give better results in term of operating cost, total net present cost, cost of energy and renewable fraction as compared to the result of [10] off grid hybrid renewable energy system.

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Biography

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