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Research paper

Prefeasibility Analysis of Off-Grid HRES for Telecom Station

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Abstract

As of now, utility has started to consider the green power innovation for having a more beneficial condition. The green power technologies lessen ignition of petroleum derivatives and the resultant co2 discharge that will be that the guideline explanation for a dangerous atmospheric warming. By boosting the use of the sustainable power source, the use of diesel generator for driving the base transceiver stations might be decreased or removed. This paper plans to research the financial, specialized and ecological execution of hybrid power systems for powering remote telecom base station. Simulations using HOMER software are performed to determine the Initial Capital, the Total net present cost, COE assist claiming the framework limit deficiency of the different supply choices. The simulation results recommend an appropriate hybrid system which might be the feasible solution for generation of electric power for remote telecom base station. A nearby examination, description and modelling of the system also are exhibited in this paper.

Keywords: *Homer; Hybrid System; Solar Photovoltaic Cell; Wind Turbine.*

1. Introduction

In the ongoing years, India's energy utilization has been expanding at a fast rate inside the world because of populace development and monetary improvement [1]. In India, Industrial consumers are the largest group of electricity consumers, followed by the domestic, agricultural and commercial consumers, therein order. The Indian telecommunications trade is one in all the fastest growing industries around the world. India is presently adding 8–10 million mobile subscribers each month [2–5]. The facility woes of India's telecommunication sector, particularly within the rural areas, are quite apparent. It's a big challenge for the exchange to fulfill its customary power needs through conventional fuel, that is expensive [6]. Power shortfalls notwithstanding the rising estimation of diesel make a major challenge to the mid-term development and gain of the media transmission segment. Proceeded with dependence on diesel additionally will well build the ecological costs inside the sort of carbon outflows. The telecommunication sector is all around set to travel to a plan of action that relies upon energy efficiency estimates together with saddling energy efficiency for its activities. This has constrained the exchange to show up for different efficient green energy arrangements. India has one in all the best potentials for harnessing the renewable energy. India has one in all the best possibilities for tackling the sustainable power source. Sustainable power sources are endless and clean. Sustainable power source Systems, fundamentally hybrid systems, have the additional preferred standpoint of being complimentary [7]. A hybrid system comprises of two or extra sustainable power sources utilized along to supply efficient power energy, expanded system productivity likewise as bigger equalization in vitality supply.

Consequently, India's developing telecommunication tower trade can do considerable value reserve funds, though lessening their non-renewable energy source reliance and carbon impression, by a move to hybrid renewable power produced power supply. The different Renewable Energy Sources (RES) like PV energy, wind energy, power modules so on are utilized for telecommunication applications inside the creating nations. The aim of research work is to check various hybrid renewable energy systems (RES) in all parts of ideal value assignment of each individual part present inside the system, sensitivity variable solar radiation, wind speed, carbon discharges, and power creation and to take a gander at the best compelling inexhaustible based for the most part hybrid system design. the proposed HRES combination for, village Palari, sub-district Kondagaon, district Bastar, state Chhattisgarh, India with latitude 19_6350N and Longitude 81_672E and also the pattern of load demand of typical telecom load profiles are fittingly modelled. Here, Hybrid optimization Model for electrical Renewable (HOMER) software package is employed to analyse hybrid power system.

2. Methodology for HRES

2.1. Load profile

The Base Transceiver Station (BTS) load is considered as an essential load. The BTS could be a telecommunication base accustomed encourages remote correspondence between supporter appliance and telecoms administrator system. Load profile The Base Transceiver Station-BTS load is considered as a basic load. The BTS could be a media transmission base acclimated energizes remote correspondence between supporter apparatus and telecoms overseer system. The overall headway of BTS is progressively happening in territories in which the capacity movement structure frequently isolates for drawn out stretches of time or where there's no passageway to the capacity give the system. That the BTS in such space, diesel generators with batteries zone unit used to move down the system for power give and certification framework availability. Regardless, these oblige relate anomalous condition of help work and eat up reasonably high proportions of diesel oil for low-level yields. Thusly, diesel generators obtain high working expenses. The creating cost of energy because of expanding diesel costs and issues over acquiring greater nursery generation have made the telecom associations to center around better power organization schedules. This power gives the subject to grid connected and the diesel generator telecom base station is imagined in fig. 1 this method conveys high cost because of overwhelming dependence on diesel generator and more regrettable execution of batteries.

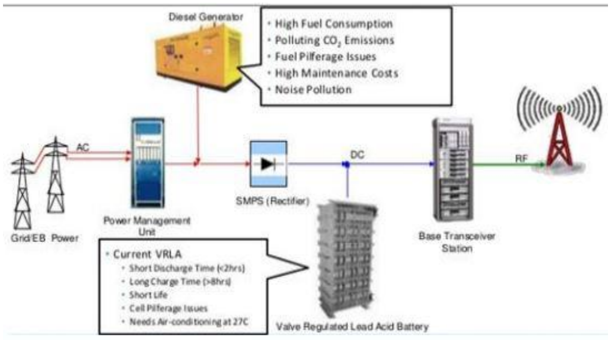

Fig. 10: Grid Connected and Diesel Generator Telecom Base Station.

Within this suggested method telecom base section observed as fill considered since 49.77 kWh/d as well as peak fill regarding day, time is 4.42 kW. The info had been tested to the get worse per hour assumption every day fill requirement of an old-fashioned telecommunications. The information was slow for the aggregate hourly premise everyday load requirement of a rustic telecom. Daily, seasonal and yearly profiles of load data are shown in fig. 2(a), (b), (c).

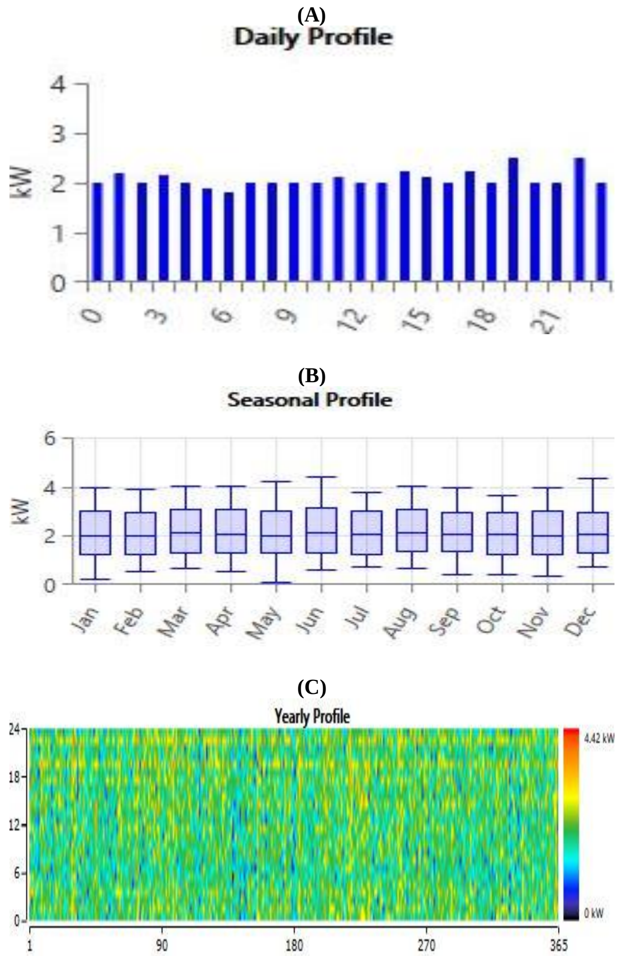

Fig. 2: A), B), C). Daily, Seasonal and Yearly Profile of Load Data.

2.2. PV resource

The PV resource used for strategic HRES installation at a location of 19_590N latitude and 81_590E line of longitude was taken from the NASA Surface Meteorology. The topographical 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 severally. The actual solar radiation is accessible whole year round; consequently, an outsized deal of PV energy output is obtained it's pictured in fig.12. In rainy season clearness index and solar energy, availableness is lower than summer and winter season. The greatest PV output obtains in summer season.

A 5kW solar photovoltaic (SPV) array is connected in series parallel while using the recommended hybrid system. At the position, if the sun rays strike SPV panels, it provides electrical power. Concerning suggested HRES, set up charge in accumulation to changing charge is usually $5000 in addition to $3000 from the 1kW solar panel. The SPV attached to DC hyperlink and the de-rating factor from of the array is 80% and the lifetime span from the SPV arrays is usually considered seeing that 20 years and no tracking system is included in the PV. Slope, the ground reflectance in percentage and azimuth (Degrees W to E) are 19.9833, 20 and 0 respectively. Weather data of the proposed hybrid system location shown in table 1.

Table 1: Monthly Solar Data

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

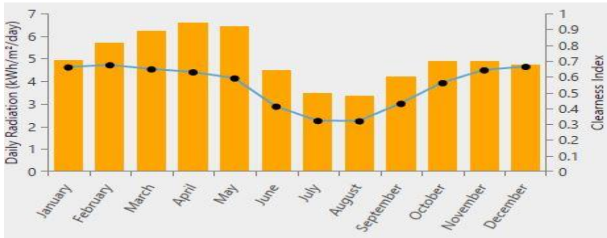

Fig. 3: Global Horizontal Radiation and Clearness Index.

Table 2: PV Module Specification

Parameters	Value
Rated Capacity	1 Kw
Capital Cost $	5000/Kw
Replacement Cost $	3000/Kw
O&M Cost $	0/Kw/Year
Derating Factor	80%
Ground Reflectance	20%
Lifetime	25 Years

2.3. Wind turbine power

The Wind energy resource, a monthly average wind speed data collected from village Palari, sub-district Kondagaon, district Bastar, state Chhattisgarh, India. This can be shown in fig.4 shown. The average wind speed data throughout the year. The time step is hour, 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 energy (A measure of however powerfully the wind speed depends on the time of day) 0.25 and 1hour autocorrelation factor (A measure of the hour-to-hour randomness of the wind speed) is 85.

Fig. 4: Average Wind Speed Curve.

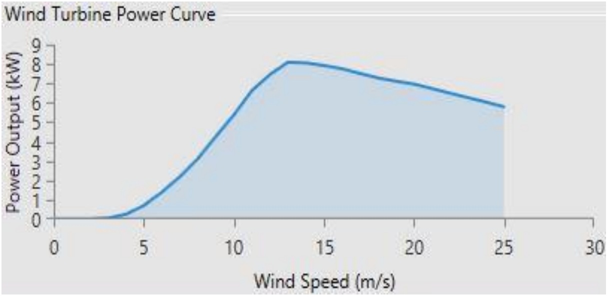

Fig. 5: A) Wind Turbine Power Curve.

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 rotary engine rating is by and massive a lot of higher contrasted with the traditional electrical load. Through this examination, Wind Power's XLR model is thought of. The lifespan of a turbine is taken to be 20 years. The rated capacity of this turbine 7.5kW DC. The fitting cost, replacement and maintenance price of this rotary engine are $1500, $1200 and $75 respectively. The wind turbine power curve and wind variation with height are shown in fig.5 (a), (b).

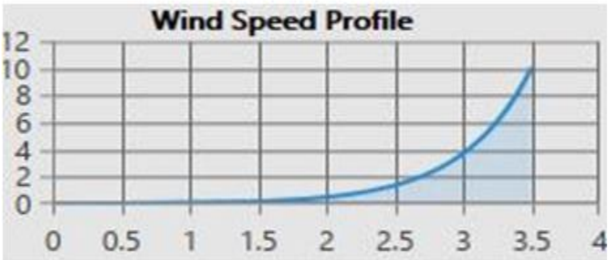

Fig. 5: B) Wind Variation with Height.

Table 3: Input Parameters of Wind Turbine

Parameters	Value
Rated Capacity	1 Kw
Capital Cost $	3000/Kw
Replacement Cost $	2600/Kw
O&M Cost $	20/Kw/Year
Lifetime	25 Years

2.4. Diesel Generator (DG)

The size of the generator is 1kW recognized as for a hybrid system. The capital cost, replacement cost and operating maintenance cost of the generator is usually $325, $225 along with $0.520 respectively. Fuel utilized for the generator is generally diesel motor alongside the cash fundamental for diesel-motor is typically differing as per abroad current market pace. The Diesel cost is utilized for sensitivity examination and distinctive estimations of diesel fuel cost are 0.8$/L, 0.85$/L, and 0.89 $/L was presented. the life of generator is normally expended since 15,000 working hours. HOMER ensures this total working pace of the generator in perspective of the proportion of the generation this ought to be utilized as a component of a year. The base load proportion (The base suitable load on the generator, as a level of its evaluated limit) is 30%. Capture Coefficient (The minimum allowable load on the generator, as a percentage of its rated capacity) is 0.08 L/hr/kW evaluated and the incline (minor fuel utilization 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 relation between efficiency and output of the generator and fuel curve are shown in fig. 6 (a). (b).

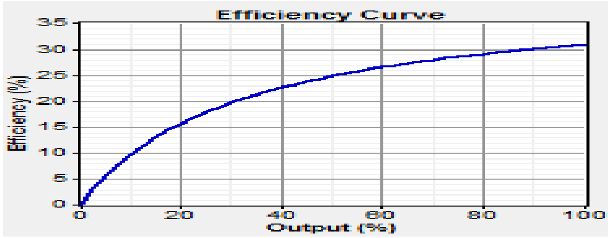

Fig. 6: A) Generator Efficiency Curve.

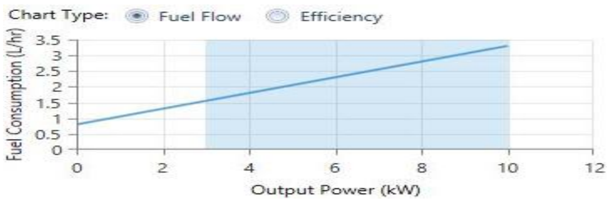

Fig. 6: B) Fuel Curve.

Table 4: Input Parameters Generator

Parameters	Value
Rated Capacity	1 Kw
Capital Cost $	325
Replacement Cost $	225
O&M Cost $/Hr	0.52
Lifetime	15 Hours

2.5. Battery-operated

The proposed technique is off-grid one in order that some sort of battery power standard bank can be used for just a backup technique along with which in turn additionally keeps regular voltage across the load. The vision 6FM200D battery power can be used to optimum hybrid system. The item is comprised 12V, 198Ah, along with 2.4kWh; suggested lifespan throughput is 917kWh along with connected in series/parallel setting. Capital cost, replacement cost and operating-maintenance cost is $280, 195$ and $5 respectively. Battery bank state of charge shown in fig.7.

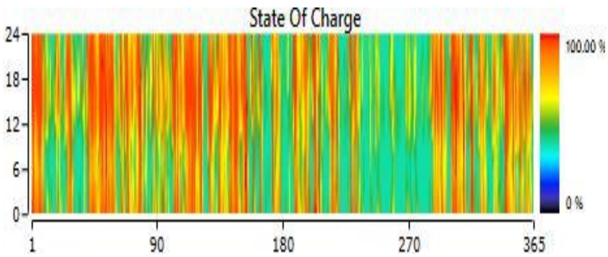

Fig. 7: Battery Bank State of Charge.

Table 5: Input Parameters Battery

Parameters	Value
Nominal Voltage	12volt
Nominal Capacity	198ah
Capital Cost $	280
Replacement Cost $	195
O&M Cost	$5/Year
Round Trip Efficiency	80%
Maximum Charge Rate	1a/Ah
Maximum Charge Current	60 A
Minimum Battery Life	4 Years

2.6. Converter

The particular SPV array output DC at a voltage, which depends on the specific settings along with the sunshine-oriented radiation.

The DC control at that point races to an inverter, which changes over it into standard AC voltage. Inverters frequently used as a piece of broad scale applications are primary inverters that offer straightforward foundation and high viability. The measuring of the specific inverter is request in entering direct current (DC) energy in the SPV and system profitability vitality of substituting electric current (AC) associated with the specific grid. The best possible estimating of inverter has skilful to take the most energy from the SPV and lower the cost of the specific inverter without troubling the specific activities in the system. The life expectancy of the converter is multiyear, and productivity is 90%. Capital cost, substitution cost and working support cost of the converter is .620, 330 and 0.0 separately [14-16].

Table 6: Input Parameters Converter

Parameters	Value
Rated Capacity	1 Kw
Capital Cost $	620
Replacement Cost $	330
O&M Cost $	20
Efficiency	90%
Lifetime	25 Years

3. Optimization and simulation

This section deals with the result of our analysis. The optimization results are presented for different type of six operating modes, which is followed by outcomes of the sensitivity analysis. The proposed system is considered at 5.00 kWh/m2/day solar radiation and 3.5m/sec wind speed. The ecological feature of system arrangement is also considered by performing carbon emission examination. In this paper, five different types of PV-Wind hybrid combinations such as PV/Battery/DG, Wind/Battery/DG, PV/Wind/DG, PV/Wind /Battery and PV/Wind/Battery/DG are analysis for optimal solution. All five-hybrid combination model is shown in fig.8.

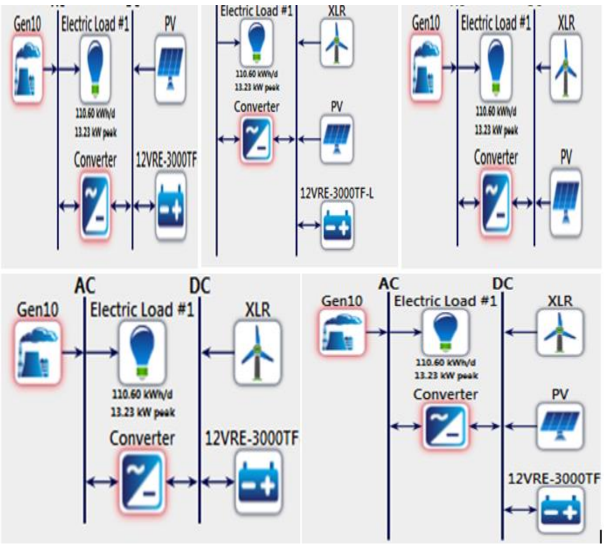

Fig. 8: PV/Battery/DG, PV/Wind /Battery, PV/Wind/DG, Wind/Battery/DG and PV/Wind/Battery/DG.

3.1. Analysis of various HRES

3.1.1. PV/battery/DG

HOMER performs simulations with respect to a number of inputs given. It identifies the best hybrid system configuration based on several combinations of equipment and their cost and ranks them in ascending order based on least NPC. In fig.9 (a). A list has been presented for different configurations. six hybrid configurations have been selected for PV/Battery/DG connected load. The principal design which is the most financially savvy one gives the least COE of $0.595kWh and most reduced NPC of $119,304 with a sustainable part of 81% is arranged with a 10kW PV, 1 kW diesel generator, 30 battery and 6 kW converters. The working and beginning expense are $4,448 and $62,445 individually fig 9 (b). Shows the monthly average electricity production for most economic hybrid configuration i.e. the first one. Fig 9 (c). Shows the cash flow summary for various equipment's of the most economic hybrid configuration.

Architecture					Cost				System	Generator	
PV (kW)	Generator (kW)	6FM200D	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Hours	Production
10.0	1.00	30	6.00	LF	$0.595	$119,304	$4,448	$62,445	81	3,356	3,053
15.0		30	6.00	LF	$0.606	$120,512	$2,612	$87,120	100		
10.0	1.00	40	6.00	LF	$0.605	$121,478	$4,399	$65,245	81	3,333	3,031
10.0	1.00	30	12.0	LF	$0.617	$123,696	$4,500	$66,165	81	3,356	3,053
10.0	1.00	50	6.00	LF	$0.617	$123,767	$4,359	$68,045	81	3,326	3,025
15.0		40	6.00	LF	$0.610	$124,105	$2,674	$89,920	100		

Fig. 9: A) A List Has Been Presented for Different Configurations.

Fig. 9: B) Shows the Monthly Average Electricity Production for Economic Hybrid Configuration.

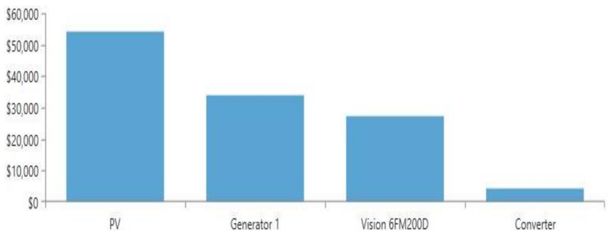

Fig. 9: C) Shows the Cash Flow Summary for Various Equipment is of the Most Economic Hybrid Configuration.

3.1.2. Wind/ battery /DG

HOMER performs simulations with respect to a number of inputs given. It identifies the best hybrid system configuration based on several combinations of equipment and their cost and ranks them in ascending order based on least NPC. In fig 10 (a) a list has been presented for different configurations. Six hybrid configurations have been selected for Wind/Battery/DG connected load. The main setup which is the savviest one gives the least COE of $0.679kWh and most reduced NPC of $132,693 with the renewable fraction of 100% is designed with a 5kW wind, zero diesel generator, 30 battery and 6 kW converters. The operating and introductory expense is $3,365 and $89,620 separately Fig.10 (b) demonstrates the month to month normal power creation for most economic hybrid arrangement i.e. the first. Fig.10(c) demonstrates the income rundown for different equipment's of the most financial hybrid design.

Architecture					Cost				System	Generator	
XLR	Generator (kW)	6FM200D	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Hours	Production
5		30	6.00	LF	$0.679	$132,639	$3,365	$89,620	100		
5		30	12.0	LF	$0.701	$137,031	$3,418	$93,340	100		
5		40	6.00	LF	$0.674	$137,089	$3,494	$92,420	100		
5		50	6.00	LF	$0.674	$141,023	$3,583	$95,220	100		
5		40	12.0	LF	$0.696	$141,482	$3,547	$96,140	100		
5		60	6.00	LF	$0.677	$144,460	$3,633	$98,020	100		

Fig. 10: A) List Has Been Presented for Different Configurations.

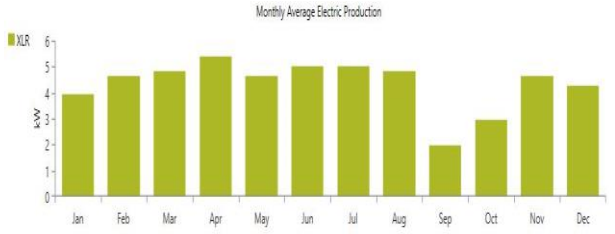

Fig. 10: B): Shows The Monthly Average Electricity Production For Economic Hybrid Configuration.

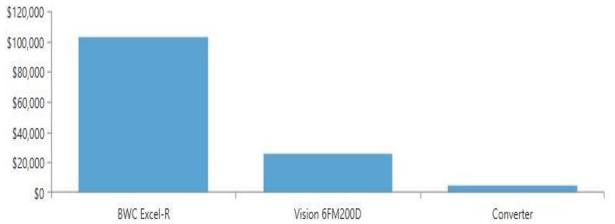

Fig. 10: C) Shows the Cash Flow Summary for Various Equipment's of The Most Economic Hybrid Configuration.

3.1.3. PV/wind/DG

HOMER performs simulations with respect to number of input given. It identifies the best hybrid system configuration based on several combinations of apparatus and their cost and ranks them in ascending order on basis of least NPC. Fig. 11 (a). A list has been presented for different configurations. Six hybrid configurations have been selected for PV/Wind/DG connected load. The main design which is the most financially savvy one, gives the least COE of $1.47kWh and most minimal NPC of $301,870 with sustainable portion of 81% is arranged with a 10kW PV, 10kW breeze, 1kW diesel generator, and 6 kW converters. The working and starting expense are $3,365 and $209,045 individually Fig 11 (b). Demonstrate the month to month normal power creation for most monetary hybrid setup i.e. the first. Fig. 11 (c). Demonstrates the income rundown for different hardware's of the most monetary hybrid configuration. This PV/Wind/DG cross breed framework not feasible solution with respect to the stability issue. Inexhaustible infiltration has sufficiently high to potential reason dependability issue because no capacity equipment in the system.

Architecture						Cost				System	Generator		
	PV (kW)	XLR	Generator (kW)	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Hours	Production	Fuel (L)
	10.0	10	1.00	6.00	LF	$1.47	$301,870	$7,261	$209,045	81	3,935	3,005	1,066
	10.0	10	1.00	12.0	LF	$1.50	$306,263	$7,314	$212,765	81	3,935	3,005	1,066
	15.0	10	1.00	6.00	LF	$1.59	$326,726	$7,250	$234,045	82	3,695	2,864	1,012
	15.0	10	1.00	12.0	LF	$1.61	$331,119	$7,303	$237,765	82	3,695	2,864	1,012
	20.0	10	1.00	6.00	LF	$1.71	$352,548	$7,314	$259,045	83	3,559	2,789	982
	20.0	10	1.00	12.0	LF	$1.74	$356,940	$7,367	$262,765	83	3,559	2,789	982

Fig. 11: A): List Has Been Presented for Different Configurations.

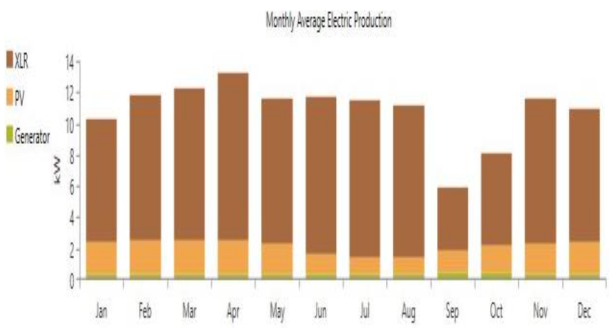

Fig. 11: B) the Monthly Average Electricity Production for Most Economic Hybrid Configuration.

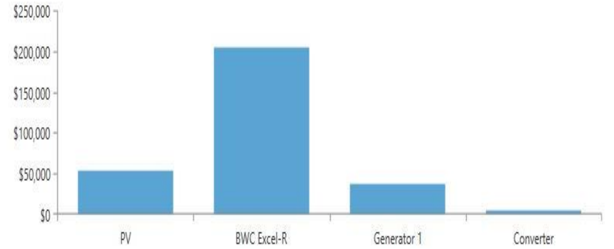

Fig. 11: C) Shows the Cash Flow Summary for Various Equipment's of the Most Economic Hybrid Configuration.

3.1.4. PV/wind /battery

HOMER performs simulations with respect to number of input given. It identifies the best hybrid system configuration based on several combinations of equipment and their cost and ranks them in ascending order on basis of least NPC. In fig. 12 (a). A list has been presented for different configurations. Six hybrid configurations have been selected for PV/Wind /Battery connected load. The economic one, has less COE of $0.501kWh and less NPC of $100,666 through RF of 100% is arranged with a 5kW PV, 2kW wind, 40 battery units and 6 kW converters. The working and preliminary cost is $2,327 and $70,920 individually fig12 (b) shows the monthly average electricity production for less costly hybrid configuration i.e. the first one. Fig 12(c) shows the cash flow summary for various equipment's of the most economic hybrid configuration.

Architecture						Cost				System	PV	
	PV (kW)	XLR	6FM200D	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Capital Cost	Production
	5.00	2	40	6.00	LF	$0.501	$100,666	$2,327	$70,920	100	25,000	7,820
	10.0	1	20	6.00	LF	$0.525	$103,223	$2,222	$74,820	100	50,000	15,640
	5.00	2	50	6.00	LF	$0.508	$103,983	$2,367	$73,720	100	25,000	7,820
	5.00	2	40	12.0	LF	$0.523	$105,059	$2,380	$74,640	100	25,000	7,820
	5.00	2	60	6.00	LF	$0.516	$107,208	$2,401	$76,520	100	25,000	7,820
	10.0	1	20	12.0	LF	$0.548	$107,616	$2,275	$78,540	100	50,000	15,640

Fig. 12: A) List Has Been Presented for Different Configurations.

Fig. 12: B) the Monthly Average Electricity Production for Most Economic Hybrid Configuration.

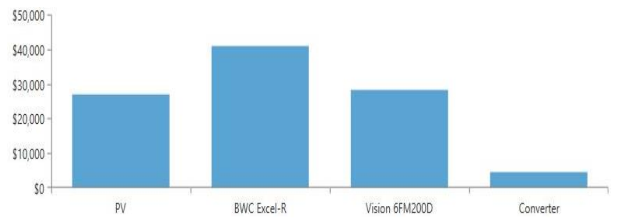

Fig. 12: C) Shows the Cash Flow Summary for Various Equipment's of the Economic Hybrid Configuration.

3.1. 5. PV/wind/battery/DG

HOMER performs simulations with respect to number of input given. It recognizes the more economic HRES based on several combinations of equipment and their cost and ranks them in ascending order on basis of least NPC. Fig.13 (a) a rundown has been introduced for various setups. Six hybrid designs have been chosen for PV/Wind/Battery/DG associated stack. The principal arrangement which is the savviest one, gives the least COE of

$0.544kWh and least NPC of $110,770 with sustainable part of 81% is designed with a 5kW PV, 1kW wind, 0kW diesel generator, 40 battery units and 6 kW converters. The working and beginning expense are $4,307 and $55,745 separately Fig.13 (b) demonstrates the month to month normal power generation for most financial crossover arrangement i.e. the first. Fig.13 (c) demonstrates the income synopsis for different apparatus of the most financial hybrid design. /Fig. 13: An) A List Has Been Presented for Different Configurations.

PV (kW)	XLR	Generator (kW)	6FM200D	Converter (kW)	Dispatch	COE ($)	NPC ($)	Operating cost ($)	Initial capital ($)	Ren Frac (%)	Hours
5.00	2		40	6.00	LF	$0.501	$100,666	$2,327	$70,920	100	
5.00	1	1.00	40	6.00	LF	$0.544	$110,770	$4,304	$55,745	80	3,581
10.0		1.00	30	6.00	LF	$0.595	$119,304	$4,448	$62,445	81	3,356
15.0			30	6.00	LF	$0.606	$120,512	$2,612	$87,120	100	
	5		30	6.00	LF	$0.679	$132,639	$3,365	$89,620	100	
	5	1.00	30	6.00	LF	$0.696	$150,066	$4,703	$89,945	91	1,714

Fig. 13: A) A List Has Been Presented for Different Configurations.

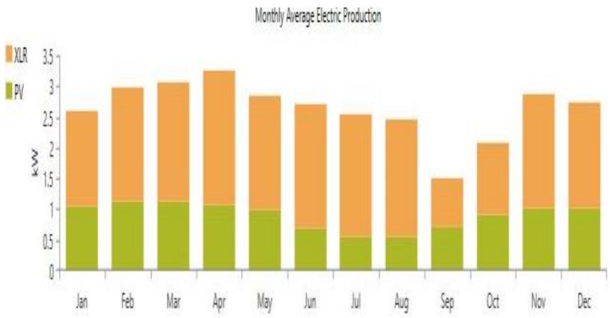

Fig. 13: B) Shows the Monthly Average Electricity Production for Economic Hybrid Configuration.

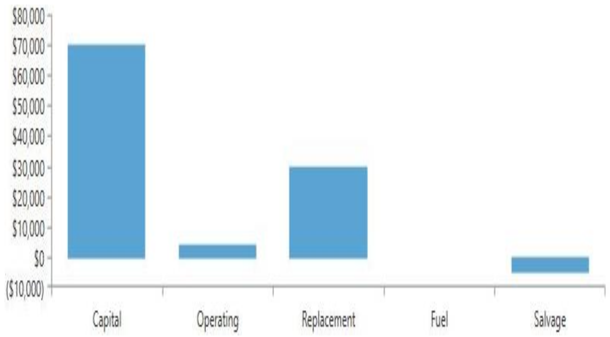

Fig. 13: C) Shows the Cash Flow Summary for Various Equipment's of the Most Economic Hybrid Configuration.

4. Results and discussions

The simulation is performed using HOMER for each hour on a yearly basis. The inputs are the hybrid selected system resources data (wind speeds, solar irradiance, and load demand, the technical and economical specification) described in the previous sections. The results of the various combinations of hybrid system are analysed and compared in table 7.

4.1. Emission

Before simulating the power system, the emissions issue is set (kg of waste matter emitted per unit of fuel consumed) for every waste matter. Once the simulation, the annual emissions are calculated off that waste matter by multiplying the emissions issue by the full annual fuel consumption. The assembly of carbon dioxide, carbon mono oxide, unburned hydrocarbon, particulate matter, sulphur dioxide, nitrogen oxides and uses the values when calculating different q & M cost are done. As shown in table 7 the hybrid combination PV/Battery/DG, Wind/Battery/DG, PV/Wind/DG produce harmful gases but the two hybrid combinations such as PV/Wind/Battery, PV/Wind/Battery/DG have not produced any gases. By using PV/Wind/Battery, PV/Wind/Battery/DG system emissions can be removed or reduced.

4.2. Production

The electricity production of varied systems depends on totally different combinations of the hybrid system. Homer calculates the electricity that may be produced by all sources, the power needed to produce the load, unmet load, and excess electricity. From the simulation results, we notice that the capability shortage among all told cases is lower in PV/Wind/Battery/DG 3,161.7 PV/Wind/Battery system. So, these systems are well adapted to satisfy 100% of the electrical demand from the base transceiver station (BTS), and the desired in operation reserve. This is often a high-quality demand for the mobile telephone sector wherever any unmet load situation or power shortage throughout the year isn't allowable. The surplus electricity produced by PV/Wind/Battery/DG hybrid system is 4,155.0 kW h/year which might be kept within the battery. So, just in case of production wise analysis, PV/Wind/Battery/DG combination is viable.

4.3. Cost ($)

The total net present cost (TNPC) is Hybrid optimization Model for electric Renewable (HOMER) software's main economic output. HOMER ranks all systems in line with the whole net present cost (TNPC). The total net present cost (TNPC) of a system is that the present worth of all the costs that it incurs over its lifetime, minus the present value of all the revenue that it earns over its lifetime. Prices include capital costs, replacement costs, O&M costs, fuel costs, emissions penalties, and, therefore, the costs of buying power from the grid. Revenues include salvage value and grid sales revenue. From the simulation result, it is analysed that the system connected with PV/Wind/Battery/DG has lowest total net present cost $100,666, levelized cost $ 0.5012 and operating cost $ 2327 as compared to hybrid combinations.

4.4. Fuel

Homer finds the energy released per kg of fuel consumed. The fuel price has taken is $0.8/L. This is utilized to compute the generator fuel cost. HOMER computes this incentive by increasing the fuel cost by the measure of fuel utilized by the generator in one year. The framework setups associated with DG devours fuel which again will expand the cost of the framework. In this way, from the above table, plainly the PV/Wind/Battery/DG crossover framework has no fuel utilization. In this way, the PV/Wind/Battery/DG framework is feasible.

4.5. Sensitivity analysis

Sensitivity analysis eliminates all unfeasible combinations and ranks the feasible combinations taking under consideration uncertainty of parameters. HOMER allows taking into consideration future developments, like increasing or decreasing load demand in addition to changes relating to the resources, as an example wind speed variations or the diesel costs. Here, varied sensitive variables are thought of to select the most effective suited combination for the hybrid system to serve the load demand.

4.6. Optimisation results

For each sensitivity case that it solves, HOMER simulates every system in the search space and ranks all the feasible systems according to increasing net present cost (TNPC).

Table 7: Comparative Analysis of Hybrid System

S. N	Description	PV/Battry /DG	Wind/Battry /DG	PV/Wind/DG	PV/Wind /Battery	PV/Wind /Battery/DG
1	Emission					
	Carbon Dioxide Kg/Yr	2,716.90	0.00	2,807.20	0	0
	Carbon Monoxidekg/Yr	6.71	0.00	6.93	0	0
	Unburned Hydrocarbons Kg/Yr	0.74	0.00	0.77	0	0
	Particulate Matter Kg/Yr	0.51	0.00	0.52	0	0
	Sulfur Dioxide Kg/Yr	5.46	0.00	5.64	0	0
	Nitrogen Oxides Kg/Yr	59.84	0.00	61.83	0	0
2	Production					
	Excess Electricity Kwh/Y	37.5	19,657.0	77,424.0	63,747.00	4,155.0
	Unmet Electric Load Kwh/Y	2,495.0	2,886.3	2,160.4	22.3	2,464.9
	Capacity Shortage Kwh/Y	3,175.6	3,537.8	3,290.9	35	3,161.7
	Renewable Fraction	80.5	100.0	81.2	100	100.0
	Max. Renew. Penetration	2,233.0	4,298.3	9,041.7	3,634.60	1,941.9
3	Cost					
	Total Net Peresent Cost $	119,304	132639	301870	6,27,750	100,666
	Levelized Cost $	0.5951	0.6786	1.47	1.2	0.5012
	Operating Cost $	4,447.90	3,365.30	7,261	23,909	2327
4	Fule					
	Total Fuel Consumed L	1,031.70	0	1,066.00		0
	Avg Fuel Per Day L/Day	2.83	0	2.92		0
	Avg Fuel Per Hour L/Hour	0.12	0	0.12		0
5	Battry					
	Energy Input Kwh/Yr	8,042.50	7,469.50	0	13,415.00	7,519.30
	Energy Out Kwh/Yr	6,472.20	5,995.50	0	11,403.00	6,063.90
	Storage Depletion Kwh/Yr	43.51	22.98	0	-35.96	55.22
	Losses Kwh/Yr	1,526.80	1,451.10	0	2,048.20	1,400.20
	Annual Throughput Kwh/Yr	7,236.20	6,703.10	0	12,368.00	6,779.70
	Expected Life Yr	3.80	4.10	0	18	5.41
6	Efficiency					
	Mean Electrical Efficiency	30.07	0	28.65		0
7	Componants					
	Generic Flat Plate PV	✓	×	✓	✓	✓
	BWC Excel-R	×	✓	✓	✓	✓
	10kw Genset	✓	✓	✓	×	✓
	Discover 12VRE-3000TF-L	✓	✓	×	✓	✓
	Converter	✓	✓	✓	✓	✓

5. Conclusion

Due to the steady growth of telecom market and associated industries in India, there's a necessity to develop a new generation DC Power supplies. It's true that the share of telecom growth in rural areas is far beyond metros. An autonomous energy system combining renewable energy sources, traditional sources and batteries or hydrogen as a storage medium was studied. This paper shows wherever solar, wind resources are available; preparation of solar, wind can satisfactorily meet energy need of remote Base Telecom Station (BTS). The simulation results indicate that hybrid systems comprising of PV/Wind/Battery or PV/Wind/Battery/DG are often feasible as this kind of has no co_2 and CO emissions. Its environment-friendly nature makes it an attractive choice to supplement the energy provide from different sources. The surplus electricity is often kept within the battery and used for future use. The price is additionally moderately less. Solar and wind are obtainable freely and, therefore, seems to be a promising technology to provide reliable power supply within the remote areas of India.

This analysis exhibits that to eliminate diesel generator, solar and wind hybrid system may be adopted. The use of solar, wind hybrid system eliminates the emission of CO2. Because the penetration of solar, wind system will increase, the surplus energy is enhanced. It will be stored and used for the future purpose by using battery bank. So, the current arrangement of diesel-powered telecommunication system will be replaced by the PV/Wind/Battery/DG system. Also, the tower structure will suitably be modified to integrate wind turbine on the tower itself, saving area and price of installations. Recommendation and future Scope of this study given below

- The non-conventional energy PV/Wind/Battery/DG hybrid power system is found to be technically feasible, emission less and cost effective in long run
- Its environment-friendly nature makes it an attractive option to supplement the energy supply in rural areas
- The service providers can have the additional benefit of carbon credit.
- The land use can be reduced by suitably modifying the BTS tower to accommodate the wind generator
- This study shows only focus on selected village Palari, subdistrict Kondagaon, district Bastar, state Chhattisgarh, India and it doesn't cover all towns and villages in this region. So, the future researchers should expand this research work in other sites and make the rural people beneficial with renewable energy resource.

The results obtained in this thesis can play a useful role in the application of hybrid renewable energy system for rural telecom base power station projects.

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