Optimally Sized Hybrid Wind Solar Energy System for Village Electrification in Indian Context.

[1]Mr. Veeresh Gonal, [2.] Dr. G.S.Sheshadri

[1]*Assistant Professor, Department of Electrical &Electronics Engineering, BLDEA's V.P.Dr.P.G.H.COLLEGE of Engineering and Technology, Vijayapur-586101,Karnataka State.*

[2]*Professor, Department of Electrical & Electronics Engineering, S.S.I.T, Kunigal Road, Maralur, Tumukur-572105. Karnataka State.*

Abstract- In the rural regions where the usefulness power bring in price is higher because of increased cost to transport the energy and due to less number of consumers, in this paper, a plan is proposed to design the by optimising the Hybrid wind solar Energy for rural electrification, particularly for village Jamny Ven Barwani of Madhya Pradesh of our country.

For the proposed work, consider a power demand of 111KWh/day. The wind solar energy system is optimised to supply the electrical energy demand of the rural users at much concessional price. For the Simulation process the, the Electric Renewable HOMER Model is used. The wind speed and solar irradiance data for the optimisation software is obtained from the Countries Metrological division. The Simulated model gave the optimised result, which has reduced the operating charges, current price of energy and also have reduced the emission of CO2 and other harmful gases to environment. The results of optimisation from the simulated model is very much encouraging regarding sizing of wind and solar PV array & Generators to meet the energy demand of the Rural users. The optimised hybrid model is very much eco friendly.

Keywords — Photovoltaic panels Array), Wind energy conversion system, wind -solar System, Optimization

I. INTRODUCTION

Designing a least priced power solution for electrical energy supply for villages and other remote areas is the most difficult work. If the electrical grids are located at a very distant place from the user's location, the transportation of the grid supply up to the consumers in the village proves to be a very costly. In the proposed design, the focus is on optimised selection of solar PV and wind energy conversion scheme to get together the electrical energy order of the village users is done by the help of HOMER software tool. The present organization gives overview information of the villages having very less population and the location of the village is very much far away from the grid, this reduces the environmental problems and increases the reliability with usage of wind-solar energy systems. In villages, the Electrical energy demand is derived from fossil fuel which emit dangerous gases in to the environment like CO, CO_2, SO_2, NO_2, etc. To avoid environment pollution, more encouragement given for the usage of the renewable hybrid wind solar pv scheme.[4] many model study on wind solar energy system have been performed.[1]describes about the effect of sizing parameter of network linked wind solar pv scheme consisting of different types of energy consuming load and power storage devices.

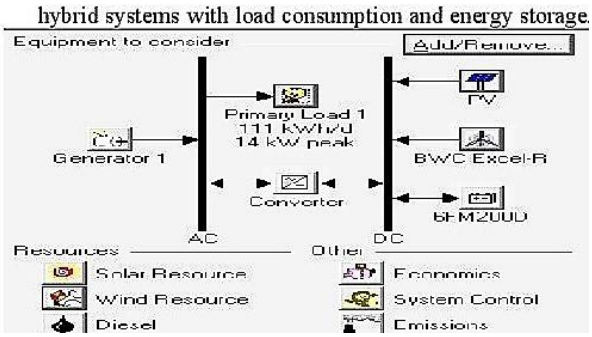

fig.1. Hybrid power system

Katsigiannis,[3] discusses about the evaluation going on living series investigation of every organization module due to green house gas discharge. Akbar,[5][6] analyses the functioning of variety of AI technique meant for minimum sizing of wind –pv method towards meet up the continuous load of the village users, with lesser total yearly cost. Sharafi,[2],used an different purpose, total most excellent possible "HRES discrimination PSO simulation approach.

In the proposed scheme plan working by means of wind solar system is AC correlated; the "Diesel Generator (DG)" [7] and wind solar power source are correlated to AC location shown in Fig.1. HOMER SOFTWARE" is used meant for the plan of wind solar system. This tool is developed by NREL, which is used as a tool for optimisation and designing. This software tool contains different energy sources like WECS, PV, DG, etc and selects the proper output based on price and ease of use of resources[8]. "HOMER"software estimation needs data regarding different resources, financial limitations and procedure of control. The data beside the nature of constituents, the numbers need, price & usefulness, long lasting endurance. Sensitivity analysis is carried out with approximate variety of values rather than real numbers.

II METHODOLOGY

The planned scheme for hybrid system constitutes of an array of solar PV panels and wind turbine, the backup system consists of DG and array of Battery. This setup is developed for off network plan at isolated region. To perform the optimisation of sizing of wind pv solar system the HRES HOMER software tool is utilised, based on the basis of three main tasks namely Study of sensitivity, Simulation and optimisation.

A. Simulation The procedure around the chosen device is reproduced by the tool HOMER. The renewable hybrid wind solar has various constituents in various sizes; the Homer tool performs the energy balance calculation based on the different classification of the system. In this research paper the PV panel's structures, Wind turbines, Diesel generators, battery bank with inverter ar chosen for analysis. The selection of the best choice which can deliver the desired electric energy at the cheaper price, will be selected by the Homer Tool. The Homer simulation is based on the cost of the Installation, O&M, and fuel, interest rate on investment, repair& replacement.

B. Sensitivity Analysis The sensitivity analysis by Homer software tool, will repeat the procedure of optimisation for the each selection of sensitivity variables. The sensitivity variables are cost of the Diesel, Wind turbine speed and sun light irradiance. The best choice for wind solar renewable system will be as per the minimum amount to largest grand total present cost. The best choice will be the one which has least total present price. Based on optimal system configuration, choice is made, which has least grand overall present cost.

C. Optimisation The process of optimisation is started for the justification of renewable wind pv solar energy system. The Homer software tool gives the list of HRES based on grand total present cost from lowest to highest.

The total sum of grand total present cost is varied based on the variables that have been chosen.

III WIND SOLAR ENERGY RESOURCES

A "Jamny Ven village Barwani" location is a very prime parameter for designing wind PV solar system. The renewable sources are naturally obtainable but not obtainable continuously, they are discontinuous in nature. Because of this reason, the first preference to supply electrical energy to meet the village users demand is renewable energy as they are naturally available & are clean energy source.

The climate information for the selected village location for renewable wind PV solar is very vital to understand the possibility of the past, the secret data. The data for wind and solar sources of selected village location is supplied by NASA [10]

A. Electrical load data"

Everyday power utilization is estimated to be "111 (kWh/day)," maximum consumption is 14KW. The data was

calculated on "hourly every day electrical utilisation condition of a place to stay "village of "Barwani district.

B. The name of the block is jamny Ven (latitude 22.71 and longitude 75.85).The energy load demand of this location is shown in Fig. 2.

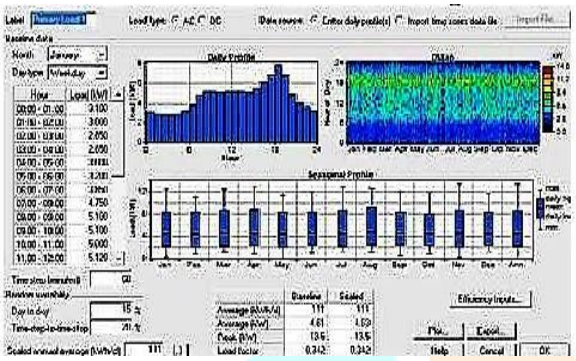

fig. 2 load demand

C. Solar energy resource:

Ever hour sun light irradiance information is recorded from the location Barwani Jamny village. Long-standing standard yearly supply scale (5.531) these statistics be measured. The fig (i), (ii), shows all twelve months PV output power present, based on the solar radiation. It is observed that the solar energy is larger in summer months in comparison to the months of winter. The solar insulation and clearance index is tabulated in Table.no.1 .

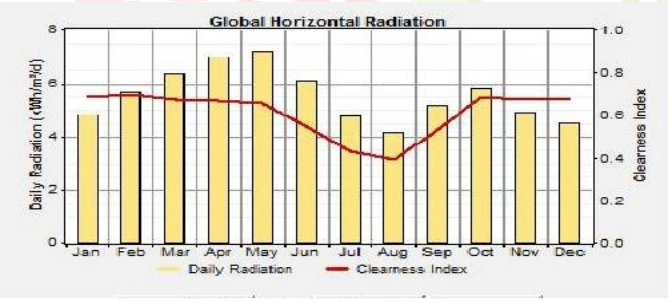

fig.3. (i) average daily radiation in a year"

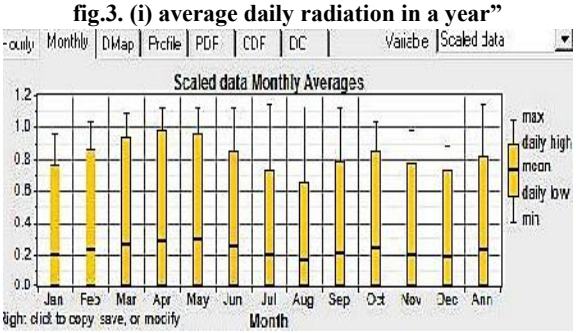

fig.3. (ii) scaled data averages

Table. no. 1.

Sl no	Months	Insulation (KWh/m^2/d)	Clearance index	Wind speed (m/s)
1	January	4.810	0.684	4.794
2	February	5.650	0.697	5.702
3	March	6.350	0.675	3.338
4	April	6.990	0.668	4.121
5	May	7.210	0.656	4.062
6	June	6.080	0.546	2.664
7	July	4.770	0.432	3.572
8	August	4.170	0.393	3.630
9	September	5.190	0.533	3.594
10	October	5.790	0.684	4.823
11	November	4.900	0.675	6.587
12	December	4.510	0.675	7.195
13	Average	5.531	0.598	4.500

D. Wind energy resource

Wind is a blow of air due to uneven heating of the earth's surface by suns radiation. The variation of the sun's position with respect to seasons of the years, varies the energy coming from the sun and also effects to the velocity of blow of the air. Power developed from the wind depends upon the area swept by the blades of wind turbine & hence the cube of the wind velocity. Presently wind energy is utilised to generate electricity to meet the increasing energy demand of the village. The wind energy is a clear & pollution free energy & is freely available in the nature. The month-wise wind speed information tabulated in table .no.1 for the village jamny Ven.

IV. HYBRID ENERGY SYSTEM COMPONENTS

A. The PV financially viable data & solar PV is PV financial data and Solar PV is coexisting in series. The PV array will produce electricity proportional to the sun light falling on it. The size of PV array used in the proposed system is 0.280kw. The price of each capacity is Rs1,03,350.00 &

Rs.94,900.00.The healthy performance is assured is 20years by a derating issue of 80% & land reflection is 20% The PV array is mounted with a slope angle 22.98 & zero azimuth correspond to south(S), & optimistic value by west-face orientations. The outcome of temperature is measured other than tracking scheme for Photovoltaic plant is ignored. The Fig.4. shows the cost curve

fig. 4. cost curve of pv

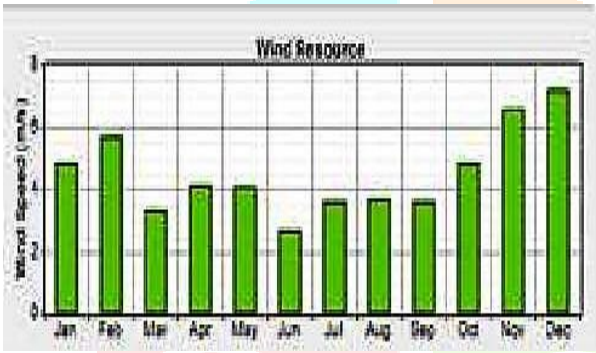

fig. 5. wind resource monthly average

B. ***Wind-turbine input*** BWC- EXCEL-RL/48 kind WT generator is used for the wind-solar power system. The highest power of BWCEXCEL-RL/48 (XLR) is 7.5kw DC. The wind turbine converts the kinetic energy of wind into electrical energy. The magnitude of electrical energy generated by the turbine depends on the wind velocity variations. The price of wind turbine used and service and maintenance cost are RS1,50,9,300.00, Rs1,15,375.0 and Rs. 31,200.00 respectively. The anemometer is mounted above the tower at the height of 30 meters, the healthy performance is expected up to 20years. The month-wise wind velocity is tabulated in table.no.1.

C. ***Generator*** The fuel operated alternator of 5kw rated capacity is used in the hybrid system which rotates at the speed of 1800rpm and generates an output AC voltage. The money investments for generator and substitution expenses are RS9, 94,500.00 and Rs..9,13,250.00 respectively. The price for generator maintenance and service amounts to be Rs13/hr. The diesel is one of the parameter used for sensitivity analysis. As on today the price of diesel is RS61.60 per litre and for remote area, the price of the diesel may get increased to Rs.70.00 per litre. The diesel generator is a backup supply for hybrid wind solar system at the said location.

D. ***Battery*** *Batteries* are used to store the electrical energy. Many numbers of batteries are connected in series and parallel form. The battery specification used in the wind solar system is model 6FM-200D, with 12v, 200Ah,2.4Kwh . The cost of each battery is Rs. 13,800 with the replacement price is also Rs.13, 800.

E. ***Power Converter*** In the hybrid system, the converter may function as an inverter to convert the DC voltage into AC voltage and also as rectifier depending upon the flow of power. Simulation proposes converter of capacity 5kW. For a 5.0 Kw system, the installation and maintenance expenses are taken as Rs.1,56,000.00 and Rs.1,52,750.00 respectively. Cost analysis is shown in Fig.4. The system performance is taken as 85%and life reliability of a unit is taken 15 years respectively.

V.OPTIMIZATION AND RESULTS

The wind-solar electric power supplies to the rural village continuously for whole year. For investigation purpose , consider different sensitivity variables as fuel cost, battery cost, wind speed and solar irradiation. To meet the energy demand of a distant village, the hybrid wind solar system is considered be the best solution. Based on the hourly time series information to supply the electric power for all months of a year, the best feasible model is simulated. The outcomes from the optimization of hybrid elements, the optimal combination of renewable energy 7.5KW BWC-Excel-R/48, ten 10KW DG.TNPC, cost of energy (Rs./kWh) and initial capital investment cost are Rs.17,111,055, Rs.33.02 and Rs.3,950,050 respectively for one year. In this particular case

simulation results provide the best possible systems configurations listed according to increasing TNPC. Granting to the initial operating cost and capital cost, the best set of contour battery storage, solar PV panels and DG system. The best solution provided by HOMER software has wind turbine, generator and battery

VI. CONCLUSION

In India, around 70% of the country's population are living in villages. The Indian government have created substations with objective to supply the best quality electrical power to rural villages. Remote area base substations are facing power problem and hence the grid expansion is not feasible and effective. The hybrid wind solar systems is the best solution for such remote village for rural electrification. This solution is cost effective and also capable of supplying electricity for all the months in a year. The study of Pre-viability of solar photovoltaic (PV) and wind hybrid power system, based on the Indian substation at far rural location, power solutions are possible. Despite the fact that the initial investment is quite high and the operation and upkeep expense are low incomparision to the different sources of energy solution. Its payback time for the initial investment is around 15 year. The remote rural village location base station power-driven by the wind solar with DG support found to be most eco friendly and also cost effective solutions for most of the difficult distant locations. The hybrid wind-solar systems are helpful to environment irrespective of whether the system is installed in populated regions or isolated regions of a village. The wind solar system also reduces the CO_2 & other harmful gaseous from getting released in the environment.

References

[1] Angel A. Bayod-Rujula, Marta E. Haro-Larrode, and Amaya MartınezGracia.: Sizing criteria of hybrid photovoltaic–wind systems with battery storage and self-consumption considering interaction with the grid. solar Energy, volume 98,(2013),pp.582-591.

[2] Masoud Sharafi, Tarek Y. ELMekkawy.: Multi-objective optimal design of hybrid renewable energy systems using PSO-simulation based approach Original Renewable Energy, Volume 68, August 2014,pp. 67-79.

[3] katsigiannis, Y.A., georgilakis, P.S., karapidakis, E.S.: Multi objective genetic algorithm solution to the optimum economic and environmental performance problem of small autonomous hybrid power system with renewable. IET Renewable Power Generation 4(5), 2010, pp.404-419.

[4] Schmid, A.L. &Hoffman, C.A.A., Replacing Diesel by Solar in the Amazon: Short-term Economic Feasibility of PV-Diesel Hybrid System, Energy Policy, Vol.32, 2004, pp.881-898.

[5] Akabar Maleki , Alireza Asharzadeh.: Comparative study of Artificial Intelligence Techniques For Sizing of Hydrogen – Based Stand-Alone Photovoltaic/Wind Hybrid System, Hydrogen Energy 39(19), 2014,pp.9973-9984

[6] M.S. Ismail, M. Moghavvemi,T.M.I.Mahila Genetic Algorithm Based Optimization On Modelling And Design Of Hybrid Renewable Energy System , Energy Conversion And Management, 85, 2014,pp.120-130.

[7] Shaahid SM, Elhadidy MA., opportunities for Utilization Of Stand Alone Hybrid (PV+diesel+battery) power system in hot climates. Renew Energy, 28(11), 2003,pp.1741-53,

[8] http: //nrel.gov./homer.

[9]http:/homepage.mac.com/unrated/solar_radiation.html.

[10] Lilienthal P Flowers L.: HOMER: The Hybrid Optimization Model for Electrical Renewable. in Proc wind power '95, American Wind Energy Association, Washington,DC, 1995,pp.475-480.