Optimization of PV Power with Diesel Generator by varying Tilt Angle and Azimuth

Shanker Warathe, R N Patel

Abstract— The Homer software is used to simulate and optimize the best result for installed solar photo voltaic power generating system of 100kw, 240V DC in Bhilai Durg (latitude °N 21.217 and longitude °E 83.433). In this paper the optimization of PV power generating system with diesel generated power will be find out with the help of Homer software which is design for it by varying the tilt angle/slope, azimuth and an incidence angle. The irradiance will vary with slope angle, azimuth, and an incidence angle so the output of PV model highly influence by the variable. The objective of this work is found out the optimization of PV system.

Index Terms— Azimuth, Distributed Generation, Homer software, Optimization power, Power tracking, Photo Voltic systeml, solar insolation, Tilt angle

1. Introduction

The generation of electricity in India is less than its de-mand. Two decad before the conventional sources was used to produce electricity. Now the scenario has changed and non conventional sources playing important role in power industry. Many local power producers are utilizing non con-ventional sources of energy to produce electricity. The shri Shankaracharya College of engineering has installed 100Kw solar power plant to meet the power requirement.

Renewable energy provides viable alternative sources for distributed generation. High performance and output of photovoltaic generation system can obtain by maximum power point tracking system. There are different tracking systems to obtain the best performance of solar cell and control technique for MPPT [1],[2]. The tracking speed and accuracy of MPPT algorithm for solar cell has discussed [3]. There are number of algorithm proposed to get maximum output from PV system [4], [5], [6]. The PV output depends on irradiation and tem-perature of solar cell nave dirrent current voltage curves for different environment. The status and future of wind energy source presented [7]. Low maintenance cost freely availability of hydel energy becomes more valuable [8]. The simulation is based on available practical data using Homer software. The software is design for electric renewable system [9], [10].

The study area located in Bhilai Durg India (latitude °N 21.217 and longitude °E 83.433) has installed a solar photo vol-taic power generating system of 100kw, 240V DC.

The author developed a tracking algorithm to get optimal output of hydrid system.

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2 Solar Photo Voltic Power Plant

2.1 spvpp

The Solar Photovoltaic Power Plants (SPVPP) is the most important applications using Photovoltaic Technology because AC power generated through the Plants can be utilized as per requirement. Solar Photovoltaic (SPV) energy generation re-fers to the direct conversion of solar energy into electricity using PV technology. When Solar Radiation falls in to Solar Photovoltaic Modules (SPV Module), DC Power is generated, this DC POWER is fed in to the PCU (Power Conditioning Unit) which converts it in to AC Power and this AC power is then fed in to Electrical Equipments. Solar radiation falling on the solar pv cell converted into electricity by photovoltaic principle. The generated current current and voltage is used to charge the battery. The generated photo voltic power is maxi-mum when solar insolation is maximum and directly depends upon it.

2.2 Following are the major building blocks of SPVPP 2.2.1 Solar Modules

This is Array of Solar Modules connected in Series /Parallel combination as per the system designed Power is generated through these SPV Modules.

The basic building block of PV technology is the solar “cell.” Many cells may be wired together to produce a PV “module,” and many modules are linked together to form a PV “array.” A complete PV system usually consists of one or more modules connected to an inverter that changes the PV's DC electricity to alternating current (AC) electricity to power your electrical devices and to be compatible with the electric grid. Batteries are sometimes included in a system to provide back-up power in case of utility power outages.

The solar photovoltaic cell model is shown in figure 1, the photovoltaic generated current Ig depends upon solar irradiance and anti diode current Id produce the non linear current voltage character-istics for solar cell [11].

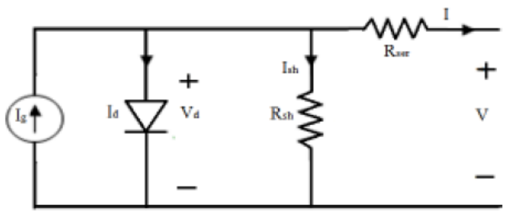


Fig. 1. Solar photovpltiac cell

The output current I is given by

$$I = I_g - I_d - I_{sh} \qquad (1)$$

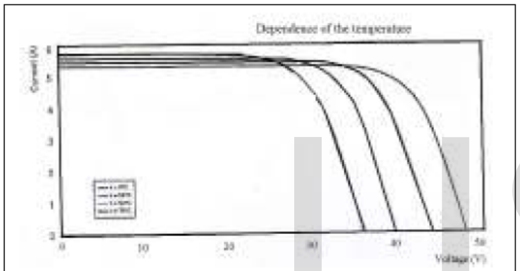
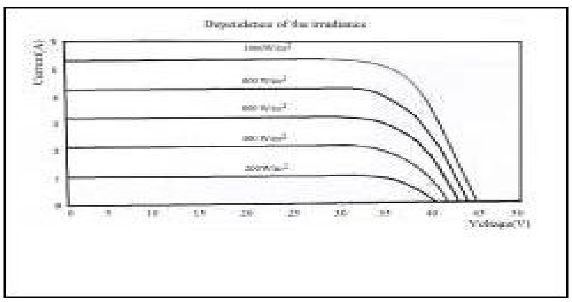


Fig. 2. Temperature dependent *I-V* characteristics of a PV array

The magnitude of generated current and voltage of PV cell depend upon the temperature and solar irradiance. The relationship between current and voltage for different temperature range is shown in figure 2 and for different value of solar irradiance is shown in figure 3.



2.2.2 Power Conditioning Unit (PCU)

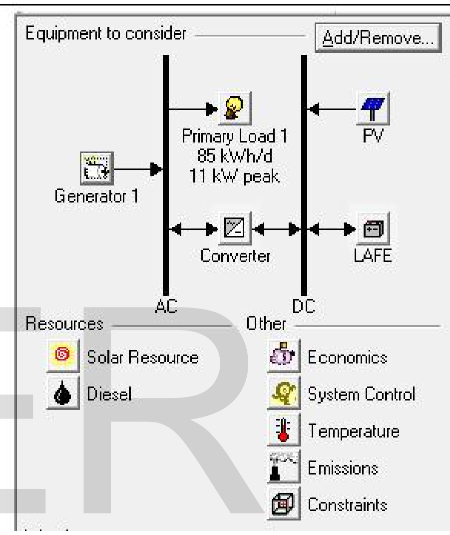
PCU is combination of Inverter and Charge controller. Charge controller's job is to provide controlled and efficient extraction of Solar Power Generated through SPV Modules for conversion in to A.C. Power or to charge Batteries. Inverter converts DC Power to AC power, synchronizes with local Grid and fed AC power in to Local Grid/A.C. Distribution Board

2.2.3 Batteries

The batterys are used as power storing device. If user needs power generated at the time when no Solar Power is available. Batteries are required for charge storage. These batteries will be Charged/Discharged through.

3 Simulation Model

The simulation model schemit is shown in figure 4, the Homer software is used for simulation. The PV mode, battery source and converter are connected to DC bus. The other model of gen-erator and load are connected to AC bus in below figure 4. The converter is connected between AC and DC bus and convert the DC power to Ac power and vice versa. The homer has a different electrical equipment model block. They can easily add or re-move from circuit. The parameter of different block can change as per requirement of simulation.



3.1 PV panel

The PV cell model is shown in figure 5, available in add/remove block of homer. The size of PV cell are consider from 10.0kw to 100.0kw in step of 10,0kw and tilt angle or slope angle are chosen from the given series 10, 11.4, 21.4, 31.4, and 41,4 degree for simulation.

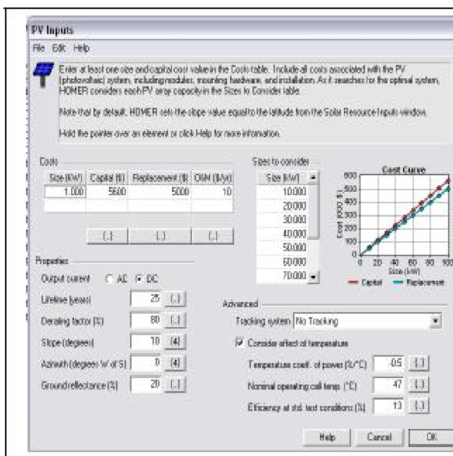
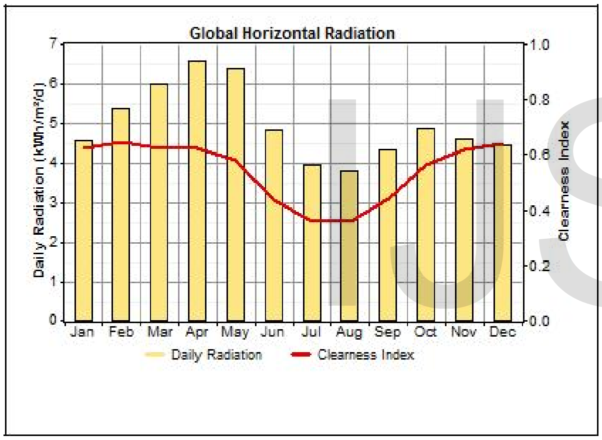


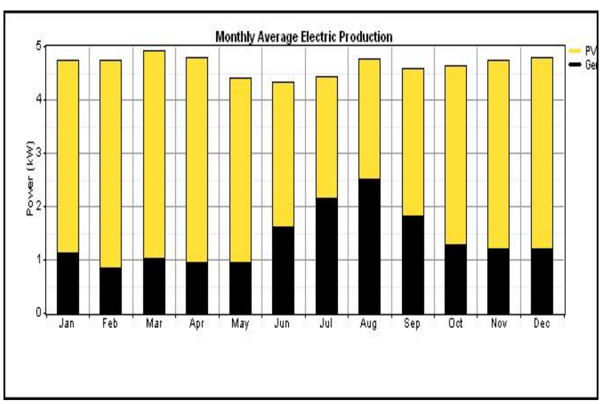
TABLE 1

SOLAR RADIATION AND CLEARNESS IN DURG BHILAI THROUGH OUT THE YEAR

Month	Clearness Index	Daily Radiation (kWh/m2/d)
January	0.626	4.560
February	0.645	5.360
March	0.627	5.980
April	0.627	6.580
May	0.582	6.380
June	0.438	4.840
July	0.359	3.940
August	0.357	3.790
September	0.443	4.350
October	0.562	4.860
November	0.617	4.620
December	0.638	4.430



The Azimuth angle consider from 0, 30, 60, 90 degree for simulation. The solar irradance and clearness index is given in table 1. For this valuves of irradince and clearness the figure 6 show the relationship. The monthly power generated by PV cell for above irradiance is shown in figure 7.



3.2 Generator diesel model

The diesel generator model block is available in Homer. The data for simulation is shown in figure 8. In the cost table, enter the generator cost curve, meaning the way the cost var-ies with size. If we have a particular generator in mind, we can enter its size and cost. In this above simulation, a 15 kW generator costs $1500 initially, $1200 to replace at the end of its life, and $0.05 per hour for operation and maintenance. HOMER only uses this table to calculate costs

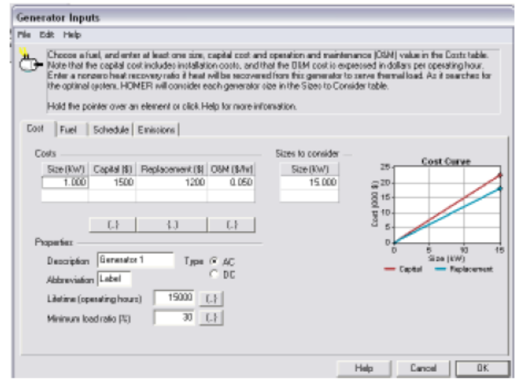


Fig. 8. Diesel Generator model

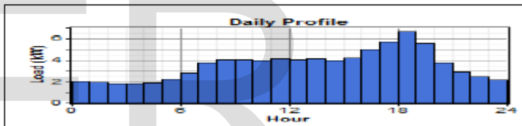


Fig. 9. Consumer Load in kW

3.3 Load Model

The consumer load is shown in figure 9 and the load model is shown in figure 10.

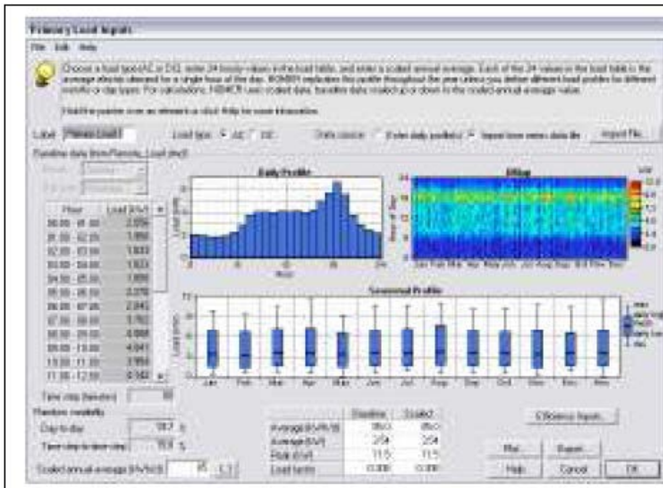


Fig. 10. Consumer Load in kW

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3.4 Converter Model

The converter model is chogen as the load and generation of electrical power in this simulation the size of converter are 100kw and 150 kW. At this vaule the simulation is run for optimization. The converter block is shown in figure 11. In the cost table, enter the converter's cost curve, meaning the way its cost varies with size. In this above simulation shown above, the capital and replacement cost of a 100 kW converter is spec-ified at $140/kW. When specifying the capital and replace-ment costs, remember to account for all costs associated with the converter, including installation

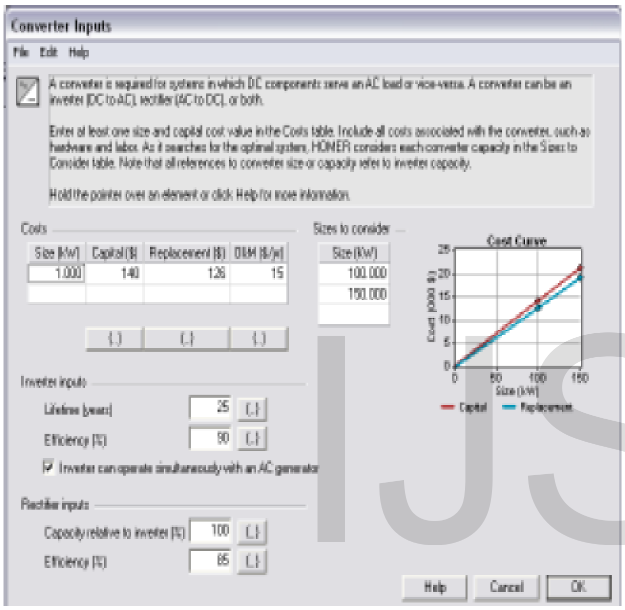

Fig. 11. Converter

3.5 Battery Model

This block allows to choose the type of battery, specify its costs, and tell HOMER how many to consider as it searches for the optimal system. When make a selection with this drop- down box, in figure12, HOMER displays a summary of the selected battery's properties in the space below. Click the Details button to see the detailed properties of the fuel. In this block, enter the battery's cost curve in as much detail as we would like. Where each battery costs the same regardless of how many we puchase, we only need to enter one row of data in the cost table. We would enter a quantity of one, along with the per-battery capital, replacement, and operating and maintenance costs. In this simulation shown above, each battery costs $ 700 initially, $ 600 to replace, and $0.10 annually for operating and maintenance.

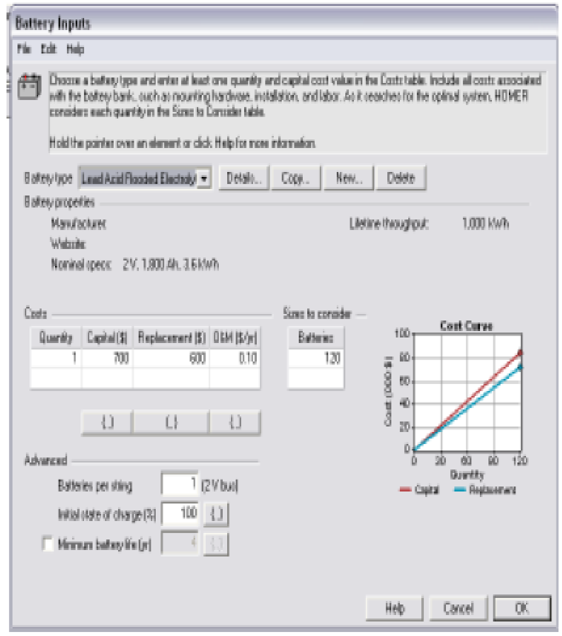

Fig. 12. Battery model

4 Simulation Result

The simulation result is shown in figure 13, the homer give the best possible optimization for hybrid system and enlist top to bottom. The first best optimization is given by homer at 10 degree PV slope and 0.0 degree azimuth.

PV Slope (deg)	PV Azim. (deg)	PV (kW)	Label (kW)	LAFE	Conv. (kW)	Initial Capital	Operating Cost ($/yr)	Total NPC	COE ($/kWh)	Ren. Frac.	Diesel (L)	Label (hrs)
10.0	0.0	20	15	120	100	$ 232,500	11,829	$ 383,710	0.967	0.60	4,265	994
10.0	30.0	20	15	120	100	$ 232,500	11,862	$ 384,133	0.969	0.61	4,226	977
10.0	60.0	20	15	120	100	$ 232,500	11,962	$ 385,420	0.972	0.60	4,271	972
10.0	90.0	20	15	120	100	$ 232,500	12,102	$ 387,202	0.976	0.59	4,397	988
21.4	0.0	20	15	120	100	$ 232,500	11,832	$ 383,759	0.968	0.61	4,251	995
21.4	30.0	20	15	120	100	$ 232,500	11,920	$ 384,878	0.970	0.61	4,180	961
21.4	60.0	20	15	120	100	$ 232,500	12,135	$ 387,632	0.977	0.60	4,267	971
21.4	90.0	20	15	120	100	$ 232,500	12,449	$ 391,642	0.987	0.57	4,570	1,014
31.4	0.0	10	15	120	100	$ 176,500	16,287	$ 384,697	0.970	0.20	8,161	1,662
31.4	30.0	20	15	120	100	$ 232,500	12,091	$ 387,060	0.976	0.60	4,287	982
31.4	60.0	20	15	120	100	$ 232,500	12,462	$ 391,808	0.988	0.58	4,435	1,002
31.4	90.0	20	15	120	100	$ 232,500	12,888	$ 397,258	1.002	0.54	4,832	1,060
41.4	0.0	10	15	120	100	$ 176,500	16,502	$ 387,450	0.977	0.19	8,293	1,697
41.4	30.0	20	15	120	100	$ 232,500	12,427	$ 391,356	0.987	0.57	4,541	1,035
41.4	60.0	20	15	120	100	$ 232,500	12,878	$ 397,120	1.001	0.56	4,715	1,056
41.4	90.0	20	15	120	100	$ 232,500	13,407	$ 403,884	1.018	0.50	5,189	1,121

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