

## An effective effort for reducing the requirement of conventional source of energy by using simulation tool

<sup>1</sup>Dhananjay yadav, <sup>2</sup>PROF V.N.Bartaria

<sup>1</sup>Dhananjay yadav L.N.C.T. Bhopal India .

<sup>2</sup>Professor V.N.Bartaria L.N.C.T. Bhopal India .

### ABSTRACT

Solar Diesel hybrid energy systems is used to reduce the consumption of conventional source of energy. To become independent unit of energy production for domestic application in urban areas, Battery bank selection is very important for energy storage in solar diesel hybrid system. Maximum consumption of energy are compensate between solar energy and diesel generator. These hybrid systems are now conveniently use in urban area for power generation in domestic applications due to advancements in renewable energy technologies and rapidly increase in prices of petroleum products. This optimal design model of hybrid solar diesel hybrid system is used as a simulation tool for optimization of system to improve efficiency. The energy stored previously at the time of high isolation provide continuous electric output. Improving the reliability of solar hybrid system to satisfying the customer requirements. The main variables in this analysis are A.C. Primary Load Calculation, Global Solar Resources, Output of solar energy, Excess Electricity and State of battery charge. First we calculate the primary load and availability of solar energy finally we prepare the optimum design of the hybrid system along with its cost estimation and expected life of battery bank. It is a compatible system which is easily installed in small area and no noise pollution. The study presented is to promote the domestic use of Solar-diesel engine with battery bank in this region of Bhopal, India (Longitude 77°42'and Latitude 23°25'). The optimization results of the hybrid system is good and this system is expecting to perform very well throughout the year with generally no battery over-discharge condition.

**KEYWORDS:** Solar-diesel hybrid system, Solar-PV, Homer, Optimization, stand alone power system

### INTRODUCTION

Stand alone system in which solar and battery powers are used together, Today peoples depends on grid supply and pay every month consumption charges of electricity. In stand alone system no need of power grid supply its an independent unit of combination solar/diesel generator/battery storage. the reliability of the system is depends on the life of batteries. when availability of sun rays in India is less due to clouds and rainy season (as in Monsoon season). Battery bank is capable of sustaining load of day and if battery bank discharge below 40%.diesel generator starts automatically. In summer session solar radiations have higher intensity.

[1] H. Dienhart, M. Falchetta All source of energy which are renewable is important in developing countries but mostly using in remote areas. It helps in urban areas also but due to the lack of awareness and research not taking the advantages of available solar resources.[2] Hybrid systems was designed by HOMER tool prove that it is feasible and sustainable power supply for hilly areas for stand alone applications. [3] Hybrid DG generation system is a reliable suitable power source for hybrid distributed generation systems with electrical distribution systems for energy management studies. [4] presented energy payback period is 8.9 years for the system having grid connectivity. In this paper advancement no grid connectivity and payback cost in 13 years. [5] The hybrid energy system also provide an solution to fulfill the power demand of shortage from grid supply. In present study of optimization of system selecting for load demand.[6] The tool homer allow user user to adjust parameters for improving the system efficiency and update the system.

## SYSTEM OBJECTIVES

The main objective for designing a Solar diesel battery system is the optimum use of solar PV system to fulfill the load requirement of the consumer, at a minimum cost of installation and maintenance. In this paper design the system with minimum losses and fulfill the requirement of load throughout the year with minimum use of diesel generator. the hybrid system has been designed based on the following steps.

(i) Power requirement, (ii) Availability of Solar, (iii) Configure the inputs for generating sustainable conditions (iv) Simulations of the sustainable Hybrid Systems, (v) Chosen of the optimum system for fulfilling the consumer requirement.

## PROBLEM FORMULATION

Today our electricity needs are totally dependent on the non renewable source of energy. Today the consumption of energy increases similarly people understand the importance of conservation of energy. In this paper the system is compatible for the domestic use in a single house. Our unit of electricity production is small and easily fitted in domestic application less space is require for installation of the system. Although it has observed that generally component failure occurs because of improper optimization of the system. The NREL ([www.nrel.gov/homer/](http://www.nrel.gov/homer/)) provided Homer tool for optimizing of Solar-Diesel hybrid system. In this paper applying proper optimization techniques and reduce the failure of hybrid system by selecting a compatible design modal for application.

## POWER REQUIREMENT

The basic step is to calculate the electrical load of domestic house and then according to this calculated load design an sustainable hybrid system. Which is capable of bearing AC primary load in order to avoid unmet load. Then enter load profile data in HOMER tool the set of 24 hourly consumption of electricity of a day. In HOMER tool we can enter load profile of single hour to whole year data of different month according to weather conditions and availability of solar radiation. The Compaq and powerful system design according to load conditions and enter data in HOMER tool and we got AC primary load calculation graph for whole year (Figure 1). In this load calculation we considered two variables: Day-to-day variable and time-step-to-time-step variable. Finally, we conclude that the scaled annual average and average load are 10.5 kWh/d and 0.436kW respectively, with the peak load of 1.72kW. where both variables are 15% and 20% respectively. Thus we should design a

Solar-wind hybrid system which can hold the 10.5 kWh/d daily with the 0.436kW average load and the peak load of 1.72kW

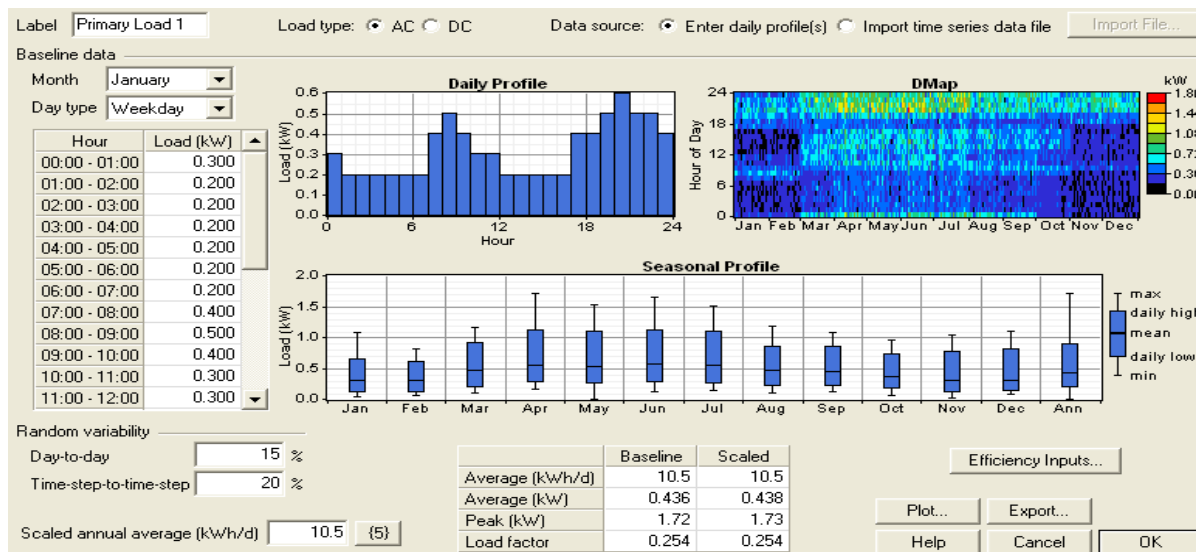


Figure 1: AC Primary Load

## AVAILABILITY OF SOLAR RESOURCES

### Solar Resource

In India availability of solar radiation is continuous throughout the year. The time zone for India is GMT +05:30 and latitude and longitude for the proposed site in Bhopal is 23°28' and 77°35' respectively. Hourly solar radiation with clearness index data for the year 2014 collected from official website of NREL [[www.nrel.gov/homer/](http://www.nrel.gov/homer/)]. This data of the year can providing by appropriate time zone, latitude and longitude. The proposed site for installation of domestic hybrid system is Nehru Nagar, Bhopal Madhya Pradesh. The solar radiation intensity is maximum during the summer season instead of winter and rainy season .After calculation we conclude that scaled annual average of solar radiation is 5.18kWh/m<sup>2</sup>/d.

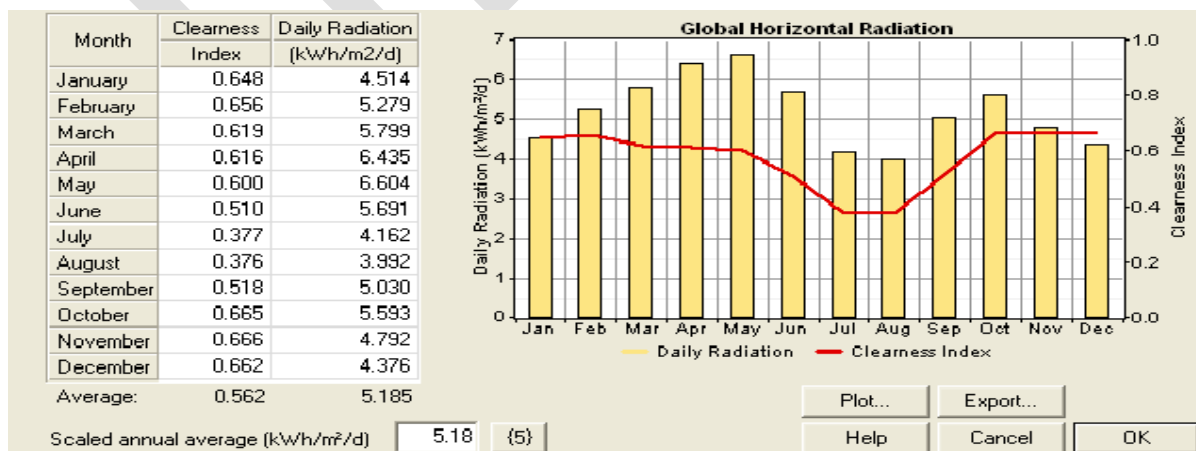
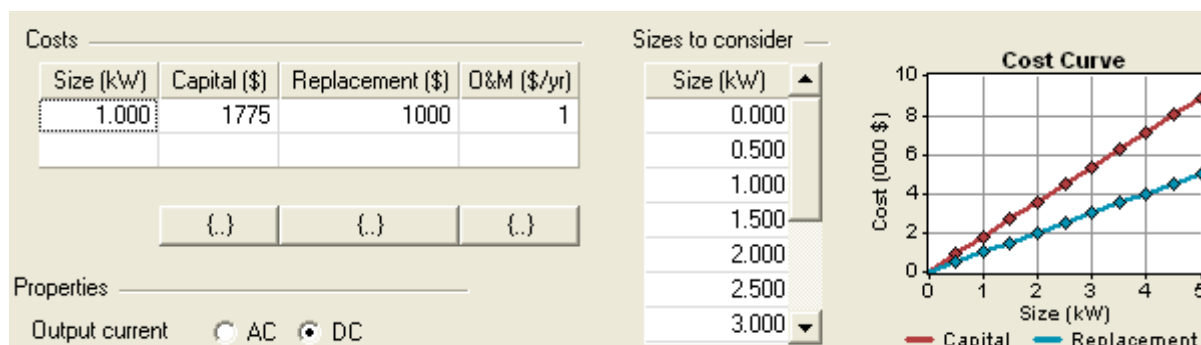


Figure 2: Average Daily Solar Radiation and Clearness Index

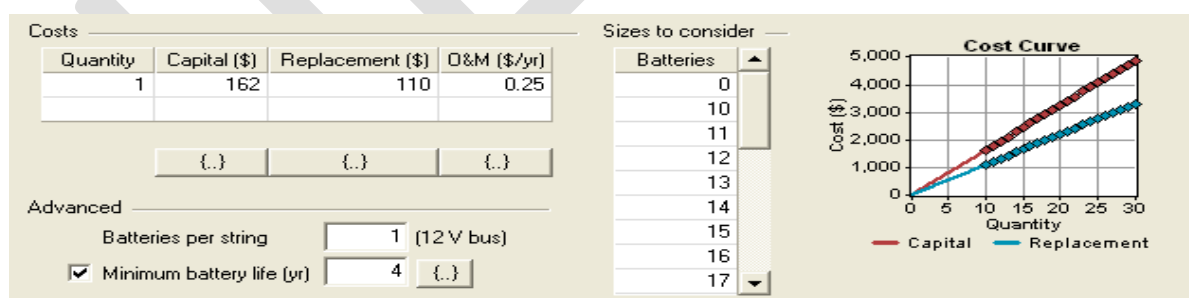
## CONFIGURE THE INPUTS FOR GENERATING SUSTAINABLE CONDITIONS



**Figure 4: PV Inputs**

### PV inputs

The PV inputs provided for the analysis in simulation tool size consider up to 5kw. After simulation the setup we consider having size of 2kw PV inputs. In figure: 4 there is a cost curve which represent the cost according to size. The cost of 1kw of PV input is 1775\$ and replacement cost is 1000\$. We are using two axis tracking system and the system having the angle of slope is 23 degree and the system receiving 20% of ground reflectance. The solar cell having nominal operating temperature is 47 degree .The cell design to be work compatibly at the temp of 47 degree. In India or in Bhopal maximum temperature attained during summer is 45 degree. The PV system life is about 20 years and having nominal maintenance just cleaning and their efficiency at standard test condition is 13% .The Derating factor for the system is 80%. Today in India the research is focused on solar because it is available source of energy and its availability hours is 8 to 10 hours every day. These hybrid system reduce the load on grid supply

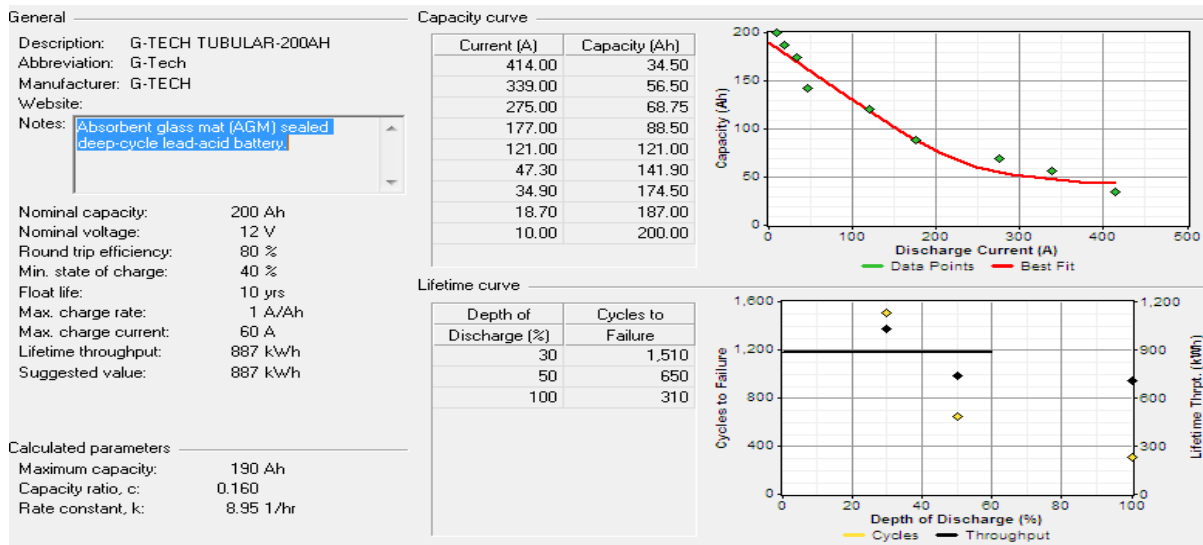


**Figure 6: Battery Inputs**

### Battery Inputs

In solar diesel hybrid system is work throughout 24 hours in a day time the system provide power but in a night time it is totally depends on the battery bank. The battery bank consist of 19 batteries in a series providing power for domestic application. The G-tech tabular batteries of 12v of nominal voltage and 200Ah (2.4kwh) nominal capacity and throughout lifetime it provide 887Kwh.The cost of 1 battery is 162\$ and their replacement cost is 110\$. The minimum lifetime years of a batteries is 4years. There is also a cost curve located in figure:6

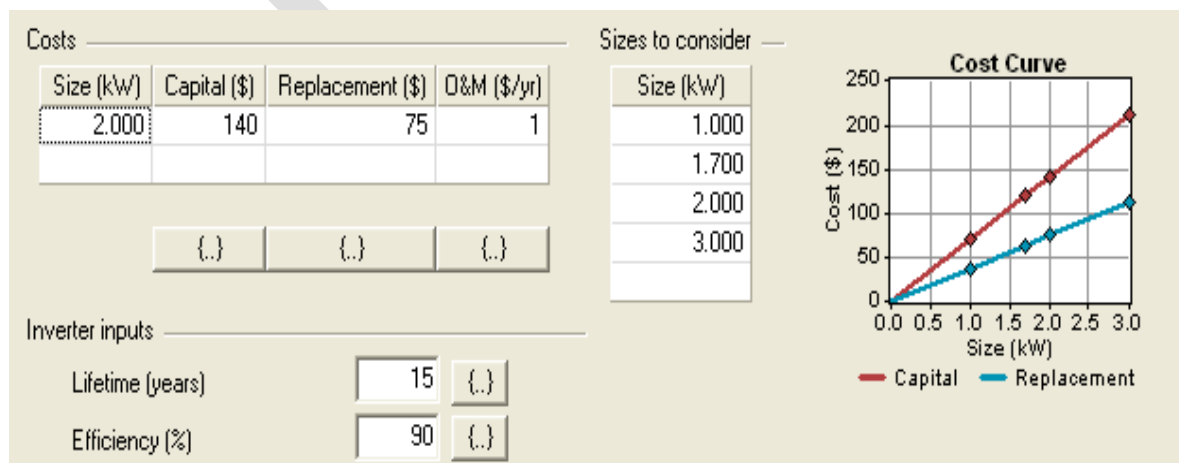
.Which represent the cost as per the quantities of the batteries we use in our system. The minimum life of tabular batteries is 4 years and use carefully it become 10 to 15 years



There is some description in figure: 7. Which shows the properties of battery the graph represents the ratio between capacity during discharge current and another graph which shows batteries depth of discharge with cycle failure the graph is lifetimes curve of the batteries. The battery bank life increases when batteries discharge level is above 40%. The G-tech tabular battery is an absorbent glass mat sealed lead acid battery having nominal capacity is 200Ah,nominal voltage is12v and having roundtrip efficiency is 80% .In the hybrid system minimum state of charge is 40% ,float life of battery is 10 years , max.charge rate 1A/Ah and maximum charge current is 60 A.

### Converter Inputs

The converter is an electronic device which converts the DC electricity that comes from PV and it converted into AC current and also stop the flow of current from battery bank to solar cell, which matches the AC frequency of the power lines. The Cost analysis for the inverter is shown in Figure 8, where lifetime of a unit is 15 years with an efficiency of 90%. The capital cost of converter is 140\$ with replacement cost of 75\$ and O&M of 1\$/yr.

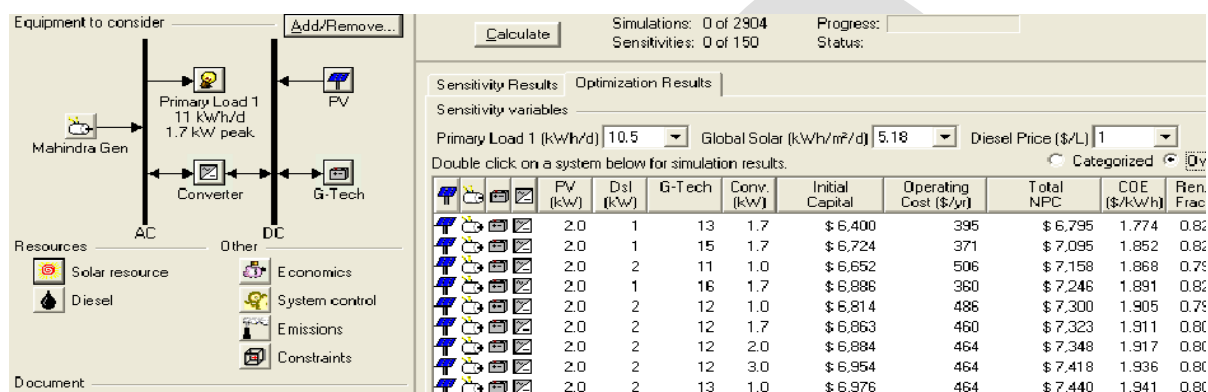


**Figure 8: Converter Inputs**

## RESULTS & DISCUSSIONS

### Simulations of the Sustainable Hybrid Systems

The calculations done by HOMER simulation of the energy balance throughout the year for each hours in year .To compare the electric demand and the energy supply by system. In year 365 days and 8760 hours. For each hour, Homer simulate the system and provide 198 sustainable configurations and the simulation completed in 52 hours 11 minutes. This results eliminate all infeasible combinations according to increasing net present cost to select an optimum system.



**Figure 8: Simulation Calculation Window**

### System Architecture

System Architecture which will bear 11 kWh/day and 1.7kWp (Figure 9):

- (i) 1 Solar PV Array, 2kWp
- (ii) 19 G-Tech Tubular Batteries, each 200AH, 12V
- (iii) Converter for 2kW peak load

### Annualized Cost Summary

The Figure 10 shows that total cost of system and individual cost of each unit. It is a combination of four units to make a hybrid system having PV module of 2 kW has the capital cost of \$3550 with \$2/yr O&M. The total annual cost of PV module in first year is \$3552. Similarly Mahindra Diesel Generator cost \$625 with \$1/yr O&M and yearly diesel consumption cost is \$309 than total yearly cost is \$935. The batteries yearly cost is \$3105. Thus total capital cost is \$7393 and Total NPC is \$7733 for the whole system.

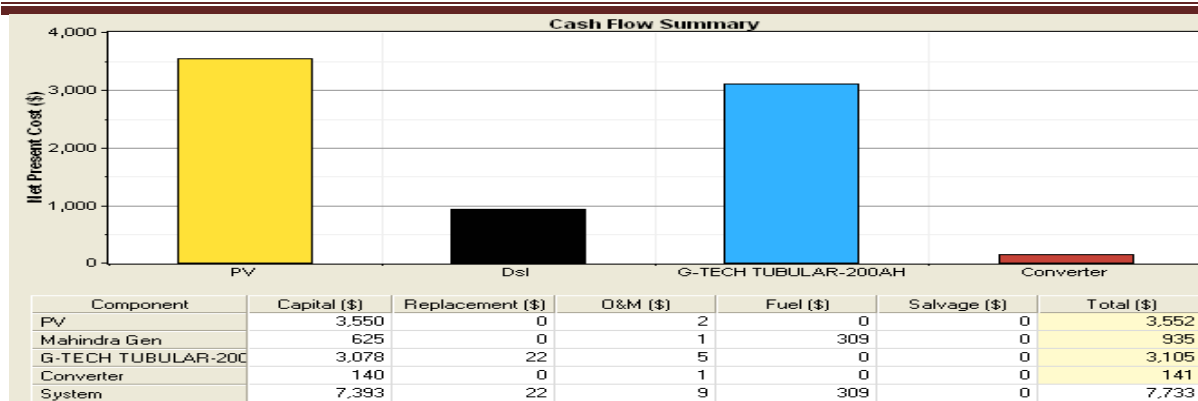


Figure 10: Cost Flow Summar

### Electrical Output of the Whole System

As per the diagram it shows total production of power and total consumption of electricity. The PV array produce 4361 kWh/yr which is 82% of total production and Mahindra Gen produce 927kWh/yr which is 18% of total production. The consumption of electricity AC primary load is 3831kWh/yr. The excess electricity after consumption is 471kWh/yr which is 8.91% .The unmet electric load is 1.20kWh/yr which is 0.03% is very nominal. Renewable fraction is 0.825

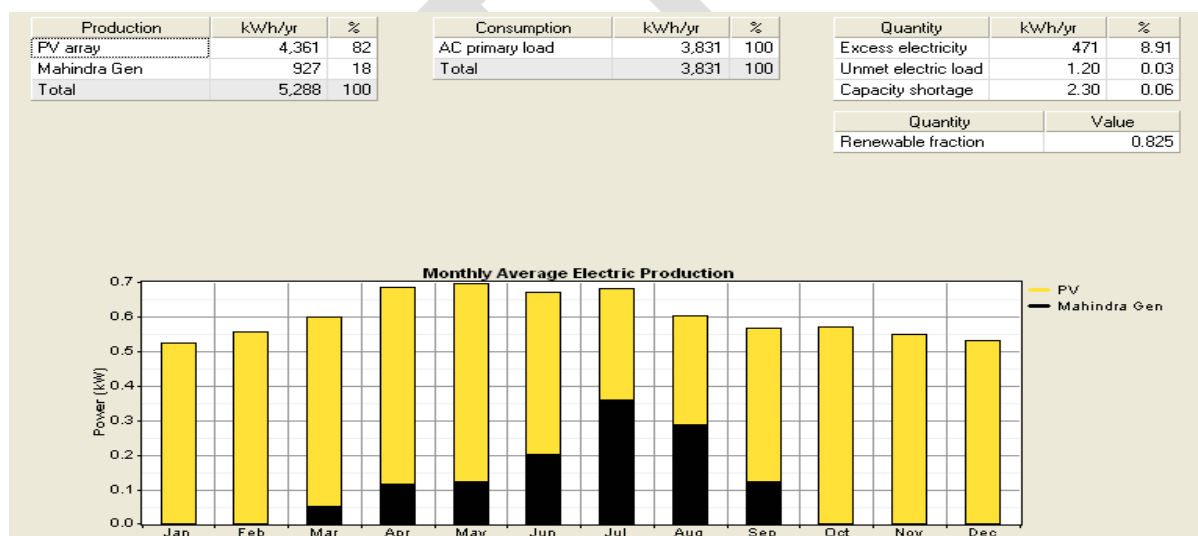
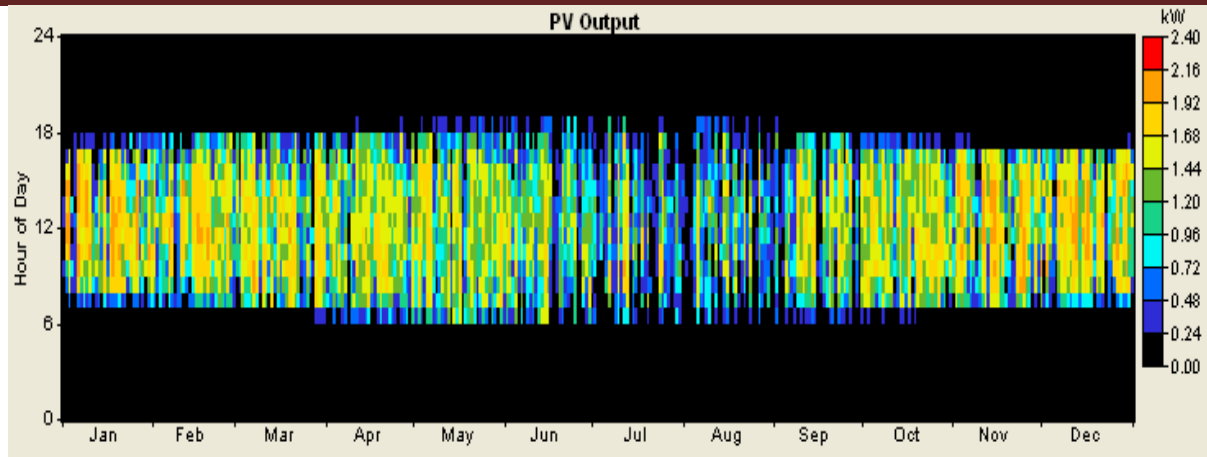


Figure 11: Electrical Output

### Solar Output of 0.3kwp Solar Array



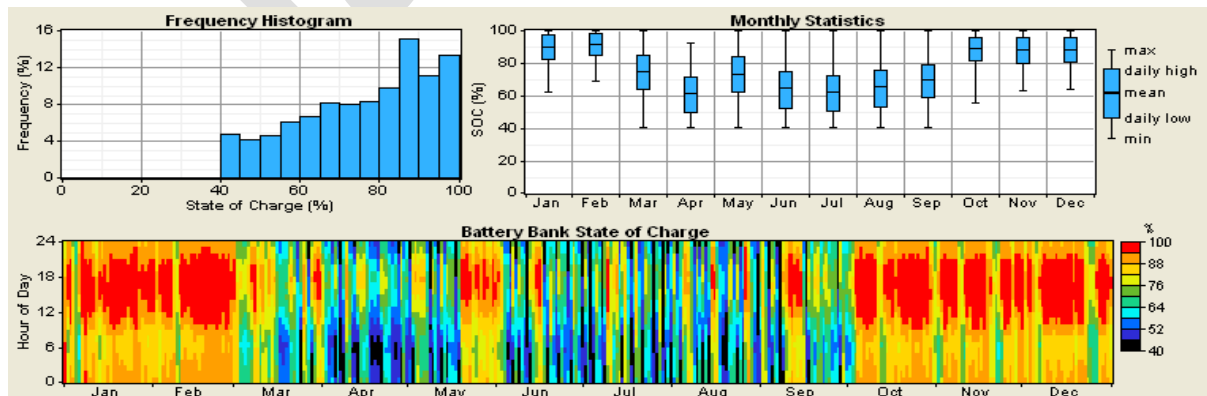
**Figure 12: Solar Output**

A 2kWp rated capacity solar array is used in the system. As we can clearly see in Figure 12, No power generation in between 06:00 PM to 06:00 AM and there is plenty of power generation in day time. Power generation by the PV array is less in monsoon season.

Some important solar outputs are:

Quantity	Value	Units	Quantity	Value	Units
Rated capacity	2.00	kW	Minimum output	0.00	kW
Mean output	0.50	kW	Maximum output	2.13	kW
Mean output	11.9	kWh/d	PV penetration	114	%
Capacity factor	24.9	%	Hours of operation	4,372	hr/yr
Total production	4361	kWh/yr	Levelized cost	0.815	\$/kWh

**State of Battery Bank Charge**



**Figure 14: State of Battery Bank Charge**

In solar diesel hybrid system battery bank is the heart of the system because the cost of yearly diesel consumption is reduce by battery bank Karaki et al. [7] represented algorithms series for battery bank of hybrid system. These shows the battery capacity and charging/discharging cycle time with respect to battery bank. The role of battery is very important in renewable hybrid system because this is the only backup for the system. In case of day of autonomy, the system will fully depend on the battery bank. The battery bank having 19 batteries string in parallel having bus voltage of 12V.

Quantity		Value	Quantity			Value	Units	Quantity			Value	Units
String size		1	Nominal capacity		45.6	kWh	Energy in		2,863	kWh/yr		
Strings in parallel		19	Usable nominal capacity		27.4	kWh	Energy out		2,297	kWh/yr		
Batteries		19	Autonomy		62.5	hr	Storage depletion		8	kWh/yr		
Bus voltage (V)		12	Lifetime throughput		16,850	kWh	Losses		558	kWh/yr		
			Battery wear cost		0.139	\$/kWh	Annual throughput		2,568	kWh/yr		
			Average energy cost		0.041	\$/kWh	Expected life		6.56	yr		

**Figure15: Battery Bank Configuration**

---

## REFERENCES

1. Dutton, A.G., J.A.M. Bleijns, H. Dienhart, M. Falchetta, W. Hug, D. Prischich, "A.J. Ruddell, 2000.Experience in the design ,sizing, economics and implementation of autonomous wind-powered hydrogen production systems. International Journal Hydrogen Energy, 25(5): 697-793).
2. E.Ferandez , "Sustainable Energy generation Using Hybrid Energy system for Remote rural Hilly Areas of India "International Journal of sustainable engineering 2010
3. Pavalos.S.Georgiolikas, "state of the art of the decision support system for the choice of renewable energy sources for energy supply in isolated regions" International journal of distributed energy sources 2006
4. Danny Li, K.L. Cheung, T. Lam and W. Chan, a study of grid-connected photovoltaic PV system in Hong Kong. Applied Energy, 2011.
5. W. D. Kellogg, M. H. Nehrir, V. Gerez and G. Venkataramanan, "Generatoin Unit Sizing and Cost Analysis for Stand-Alone Wind, Photovoltaic, and Hybrid Wind/PV systems," *IEEE Trans. On Energy Conversion*, vol. 13, No. 1, Mar. 1998.
6. Hybrid Optimization Model for Electric Renewables (HOMER). <<http://www.nrel.gov/homer/>>
7. Karaki, S. H., Chedid, R. B. & Ramadan, R. (1999). Probabilistic performance assessment of autonomous solar-