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# Economical Analysis of Integrated Wind and Solar Power Generation Standalone System With Energy Storage Device

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***Abstract:*** *Through this paper, we are to familiarize the first notion of Optimized PV-Solar and Wind Hybrid Energy System. The goal of the paper is to generate electricity, then supplying it to the Community/Village, Excess electricity will supply to the battery. On behalf of the hybrid system climatological data on Solar radiation plus every 60 minute wind speed has collected from community/village (Latitude 13°0.4'N and Longitude 79°7.8'E) and over the learned configuration capacity of load intake of community/village and taught the plan of a paradigmatic model of community/village was optimized by using HOMER software. Since evaluating the size and to the get most feasible structure regard hybrid non-conventional energy system by using the hybrid optimization model for electric renewable (HOMER) software*

***Keyword:*** *Hybrid Power System, Rural Electrification,Solar-wind turbine, sustainability of power supply, techno economically viable power.*

## I. Introduction

The community / village having the geographical location of [latitude13°0.4'N, and Longitude 79°7.8'E] was really capable and bounteous solar, wind energy is present. In the present situation we are obtaining more solar energy and wind energy, although we are using a very small level of solar and wind energy for production of power. So that, we have modeled the hybrid system which is the combination of non-conventional energy of solar, wind along with batteries. Because of seasonable situation; Production of non-conventional energy is often interrupted naturally and to reducing the wind energy voltage fluctuation, we are using the batteries so that our load (community/village) frequent power interruption will be avoided. As for implementing hybrid system, solar and wind energy with battery. The installation cost is high, but the cost of energy and maintenance cost for power production is low and the hybrid system of non-conventional wind and solar energy is pollution free, as it is pollution free it will not affect living beings. The cost benefit analysis of non-conventional wind and solar power generation hybrid system is analyzed, sized and optimized by using HOMER software. The cost benefit analysis of solar wind power hybrid system has a payback period the related charge of kilowatt utility power supplied to the village was presented in this paper. The economical appraisal of technology would also promote adoption and to continuous power supply.

## II. Standalone System

To produce electricity from non-conventional power generation hybrid system different sources such as solar panels and wind turbine, these systems consist of storage equipment which include battery banks, it consists of 50 kW of solar and 60 kW of wind turbine and 420 battery and A.C wind power converted to D.C stored in the battery.

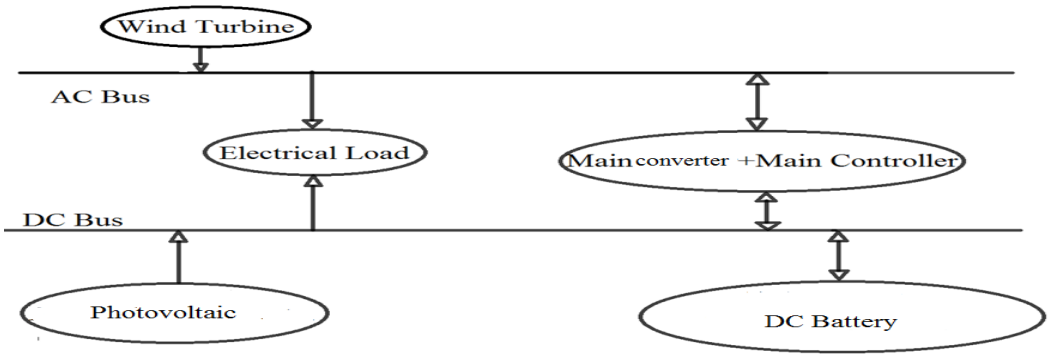



**Fig. 1** Block Diagram of Standalone System

The voltage obtaining from battery is constant A.C voltage and then it is given to the Load therefore variation of voltage are avoided in this system

## III. Introduction To Photo Voltaic Cells

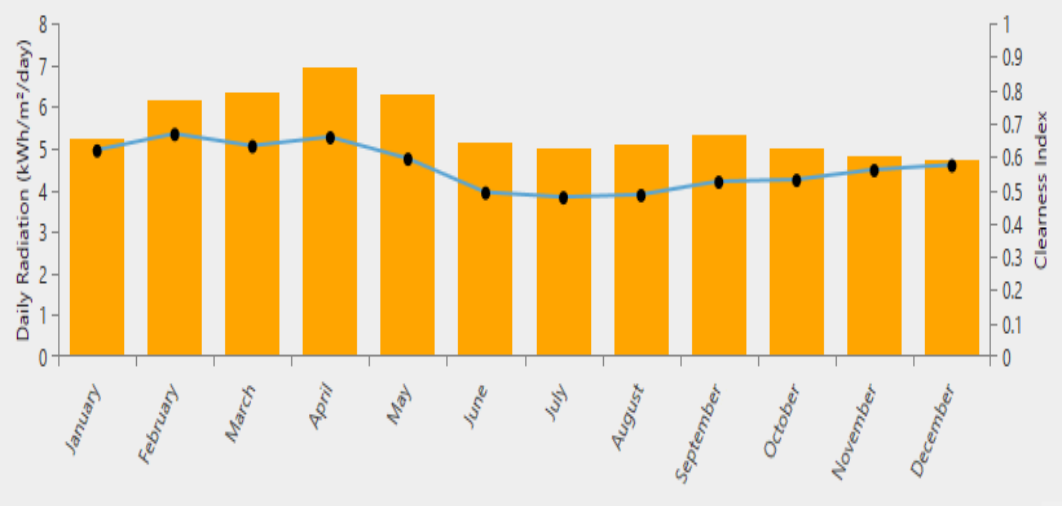



**Fig.2** Solar Radiation Chart

*Photo voltaic* cells are very important in the production of power generation. Without *photo voltaic* PV cells in the universe, we cannot produce power from solar radiation. But, it is inadequate in power production. Solar energy is very useful for our country; it requires for the very small area at ground level or in a building top for domestic holder so that it is very useful to satisfy our country power demand and by installing a standalone system. We are reducing the transmission losses for power transfer in the power system network, but it is inadequate in power production as same that of the computer is made of silicon in short and medium *photo voltaic* panels but silicon is having bounteous of minerals. For installation of solar PV panel, there are two types panels are available

Those are

1. Monocrystalline
2. Polycrystalline

For the installation, manufacture, the production cost is high, when direct solar radiation strike on the PV Panel Voltage difference will occur in PV cell because of that current will pass in an electrical circuit, to protect the solar panel from grime, the glass frames are constructed over PV panel. To charge a 12 Volt battery, PV cell is connected either parallel or series. At the time of the sun rays occurrence period directly it is capable of producing 16 volts from 12 volt panel the lifetime of PV panel is series addition of voltage will produce, in parallel connection addition of current will produce total models connected for 50 kW solar power generation system of capital and production cost are taken as ₹ 15, 29,375 and ₹ 65,001 correspondingly

## IV. Distributed Energy Sources In Community/Village

There are no earth measurement data on solar radiation. But from the National Renewable Energy lab database. It has been found that the solar insolation over community/village is 5.50 (kWh/$m^2$/day) from table 1 shows the values of monthly solar insulation on horizontal surfaces for community/village observed from the National Solar Radiation database

**Table I.** Ghi Values For Community/Village

| Month | Clearness Index | Daily Radiation (Kwh/$M^2$/Day) |
|---|---|---|
| January | 0.616 | 5.232 |
| February | 0.666 | 6.166 |
| March | 0.630 | 6.348 |
| April | 0.656 | 6.923 |
| May | 0.592 | 6.271 |
| June | 0.490 | 5.153 |
| July | 0.476 | 5.005 |
| August | 0.483 | 5.072 |
| September | 0.522 | 5.325 |

| | | |
|---|---|---|
| October | 0.528 | 4.998 |
| November | 0.558 | 4.815 |
| December | 0.572 | 4.694 |

The Information gathered from NASA surface meteorology, the wind speed at 50 m above the surface of the earth for terrain identical through Aerodrome, One decade's appraisal for every average month

**Table II.**Wind Speed Data For Community/Village

| **Month** | **Average (M/S)** |
|---|---|
| January | 3.960 |
| February | 3.850 |
| March | 3.920 |
| April | 3.940 |
| May | 4.330 |
| June | 4.930 |
| July | 4.8 |
| August | 4.640 |
| September | 3.430 |
| October | 3.170 |
| November | 3.650 |
| December | 4.230 |

## V. Wind Turbine

After simulation of small wind turbine 10Kw capacity wind turbine of six small wind turbine optimal for the geographical location. The predicted capital cost is ₹ 600,000 and
₹ 28,140. The power curve is shown in fig 3.

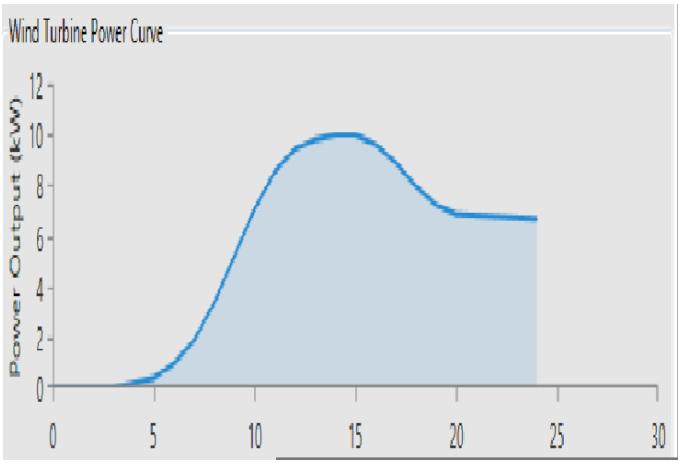



**Fig. 3**Wind Turbine Power Curve

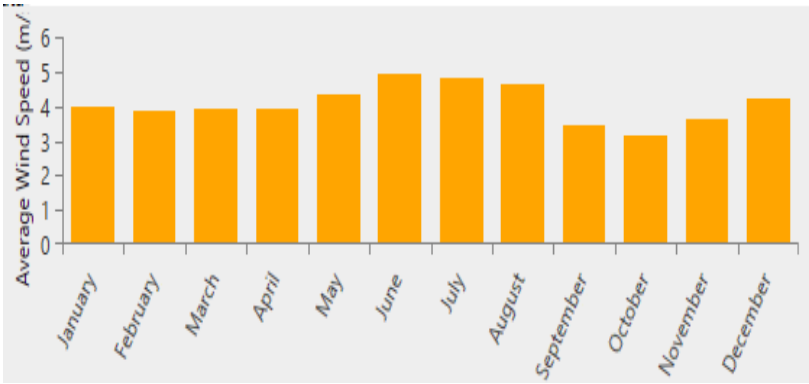



**Fig.** 4Average Wing Speed Chart

## VI. Battery

The battery type generic 1 kWh lead acid and nominal voltage 12v, maximum capacity (AH): 83.4,

maximum charge current (A):16.7, max discharge current (A): 24.3 the expected life of battery is 10 year battery capacity, cost ₹ 7,55,580 and replacement cost is ₹ 3,33,754 Discrepancy of solar and wind energy generation do not equal the time distribution of demand. Therefore power generation system prescription the association of battery storage facility to smooth the instant distributions divergence between the solar/wind and load energy Generation and to account for maintenance of the system analysis

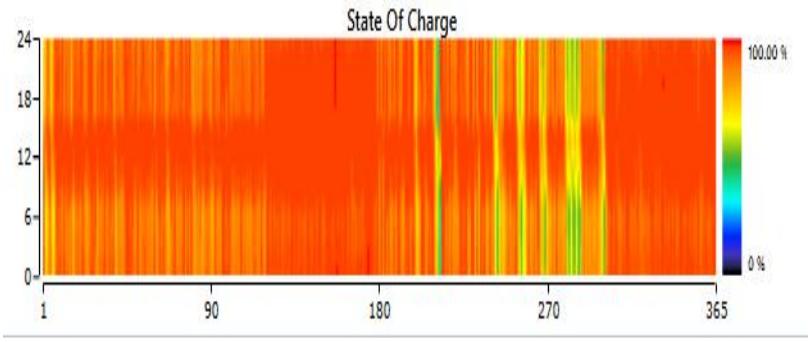



**Fig.5** Battery State of Charge

**Table III.**Generic 1kWh Lead acid

| Quantity | Value | Unit |
|---|---|---|
| String size | 4.00 | |
| String in parallel | 105.00 | |
| Batteries | 420 | |
| Bus voltage | 48 | V |
| Nominal capacity | 420 | KWh |
| Usable nominal capacity | 252 | KWh |
| Autonomy | 55.49 | Hr |
| Lifetime throughput | 336000 | KWh |
| Battery wears cost | 1.26 | ₹/kWh |
| Average energy cost | 0.00 | ₹/kWh |
| Energy in | 16,204,00 | KWh/yr |
| Energy out | 12,968.00 | KWh/yr |
| Storage depletion | 4.91 | KWh/yr |
| Losses | 3,231.30 | KWh/yr |
| Annual THROUGHPUT | 14.499 | KWh/yr |
| Expected life | 10.00 | Year |

## VII. Simulation And Optimization

The study shows the cost of energy 12.43 (kWh) is for the system which is for community/village figure. 1 shows the monthly power production for single optimization mode of the proposed micro grid system; Table IV reveals the greenhouse gas emission of the proposed system. Homer software performs several simulations in order to obtain the optimal hybrid system. One sensitivity variable is considered in the system the wind speed, solar irradiation and load are considered and each of the variables has three different values the optimization result show the best optimal combination of energy system component are 50kW generic flat plate PV, rated capacity 10 (kW) and wind generic 10kW, rated capacity 10kW and 420 battery capacity 1kWh lead acid with nominal voltage (v): 12.maximum capacity (Ah): 83.4


**Fig.** 6Monthly Average Electrical Output

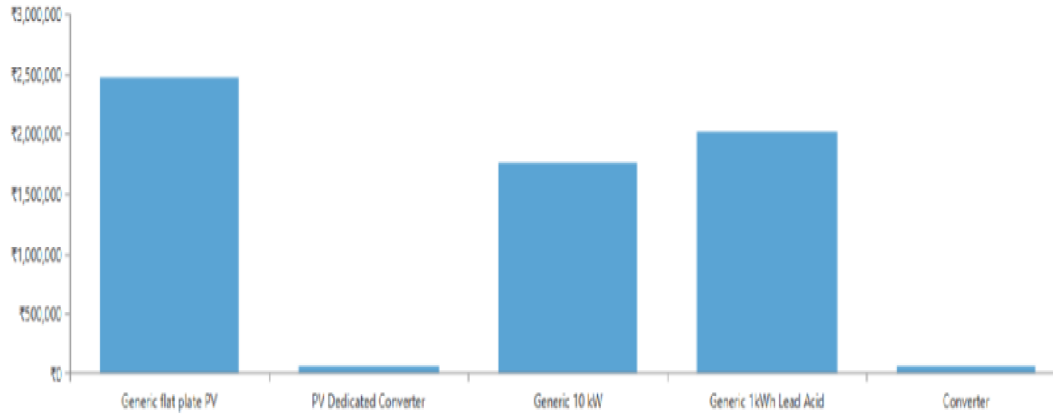
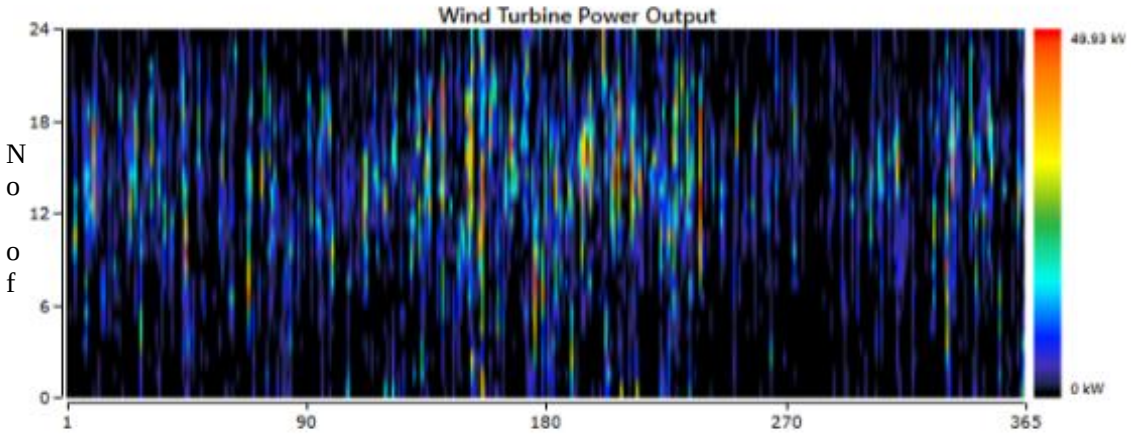
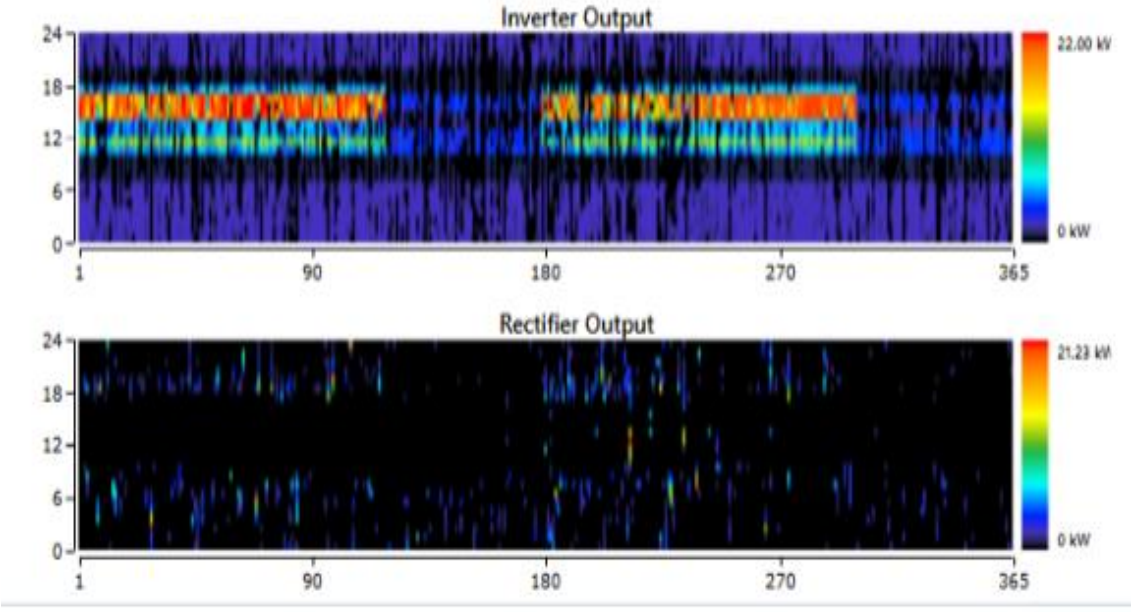



**Fig. 7** Cost Summary of Optimization Case




No of days

**Fig. 8** Wind Turbine Output




No of Days

**Fig. 9** Inverter and Rectifier Output

**Table IV**. Optimized Architecture Output

| Component | Capital cost | Replacement Cost |
|---|---|---|
| Generic flat plate P V | ₹ 1,500,000 | ₹ 0.00 |
| P V Dedicated converter | ₹29,375.00 | ₹ 0.00 |
| Generic wind 10kW | ₹600,000 | ₹ 0.00 |
| Generic 1kWh Lead | ₹ 755,580.00 | ₹ 333,754.00 |
| Converter | ₹29,375.00 | ₹ 0.00 |
| System | ₹2,914,330.00 | ₹ 333,747.00 |

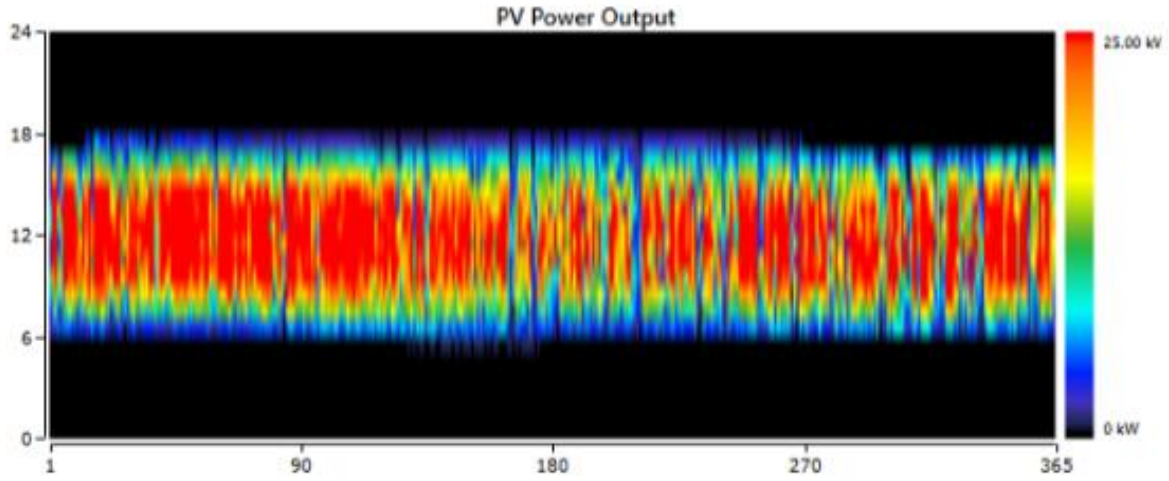



**Fig.** 10 PV Power Output

**Table V**. Optimized Architecture Output

| Component | O&M | Fuel |
|---|---|---|
| Generic flat plate P V | ₹969,563.00 | ₹ 0.00 |
| P V Dedicated converter | ₹ 37,975.00 | ₹ 0.00 |
| Generic wind 10kW | ₹ 1,163,476 | ₹ 0.00 |
| Generic 1kWh Lead | ₹ 976,777.00 | ₹ 0.00 |
| Converter | ₹ 37,975.00 | ₹ 0.00 |
| System | ₹ 3,185,765.00 | ₹ 0.00 |

**Table VI.**Optimized Architecture Output

| Component | Salvage | Total |
|---|---|---|
| Generic flat plate P V | ₹ 0.00 | ₹ 2,469,563.00 |
| P V Dedicated converter | ₹0.00 | ₹ 67,350.00 |
| Generic wind 10kW | ₹0.00 | ₹ 1,763,476.00 |
| Generic 1kWh Lead | ₹45,251.00 | ₹2,020,859.00 |
| Converter | ₹0.00 | ₹ 67,350.00 |
| System | ₹ 45,251.00 | ₹ 6,388,599.00 |

**Table IV.** Greenhouse Gas Emissions

| Pollutant | Emissions | Units |
|---|---|---|
| Carbon monoxide | 0 | kg/yr |
| Particulate matter | 0 | kg/yr |
| Sulfur dioxide | 0 | kg/yr |
| Nitrogen oxides | 0 | kg/yr |

## VIII. Conclusion

Homer software was used for power optimization and applied to performance of a wind-solar non conventional hybrid power generation system, the vital intonation of the paper is to suggest the scheme based on the balance among environment, economy and energy is vital study in the behavior of hybrid system which allows employing renewable and variable in time energy source.The result reveals the cost of energy of the optimized system is ₹ 12.43, System capital cost ₹ 2,914,330.00, replacement cost ₹ 333754.00 and O&M ₹ 3,185,765.000,fuel cost ₹ 0.00, salvage ₹ 45,251.00 and Total cost ₹ 6,388,599.00

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