International Journal of Advance Research in Science and Engineering
Vol. No.4, Special Issue (01), September 2015
www.ijarse.com
IJARSE
ISSN 2319 - 8354

APPLICATION OF HYBRID ENERGY FOR POWER PRODUCTION AT CONSTRUCTION SITES

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ABSTRACT

Power crisis is one of the main concerns of the Indian society and increasing demand of the power is leading to depletion of available sources of energy i.e. fossil fuels. This is leading to shortage of fossil fuels ultimately leading to power crisis and increasing power charges. Renewable energy is a new emerging technique being developed to solve the problem of this shortage of fuel and power crisis. By combining two and more renewable source we can increase the efficiency as well as greater balance in energy supply. The combination of two or more renewable energy is known as hybrid renewable energy. Our project aims at the analyses of various processes at construction site and building a prototype on the basis of data we got from construction site visited on a small scale by using combined wind –solar energy.

Keywords: Hybrid Energy, Charge Controller, Battery Line Inverter, Homer, Wind Turbine, Photovoltaic Cells.

I. INTRODUCTION

Electricity is most needed for our day to day life. There are two ways of electricity generation either by conventional energy resources or by non-conventional energy resources. Electrical energy demand increases in word so to fulfil demand we have to generate electrical energy. Now a day's electrical energy is generated by the conventional energy resources like coal, diesel, and nuclear etc. The main drawback of these sources is that it produces waste like ash in coal power plant, nuclear waste in nuclear power plant and taking care of this wastage is very costly. And it also damages he nature. The nuclear waste is very harmful to human being also. The conventional energy resources are depleting day by day. Soon it will be completely vanishes from the earth so we have to find another way to generate electricity. The new source should be reliable, pollution free and economical. The non-conventional energy resources should be good alternative energy resources for the conventional energy resources. There are many non-conventional energy resources like geothermal, tidal, wind, solar etc. the tidal energy has drawbacks like it can only implemented on sea shores. While geothermal energy needs very lager step to extract heat from earth. Solar and wind are easily available in all condition. The non-conventional energy resources like solar, wind can be good alternative source. Solar energy has drawback that it could not produce electrical energy in rainy and cloudy season so we need to overcome this drawback we can use two energy resources so that any one of source fails other source will keep generating the electricity. And in good weather condition we can use both sources combine.

Review by different authors:

FESLI U ET AL [1]: solar photovoltaic system: the European PV industry association reporter that the total global PV cell production worldwide in 2002 was over 560 MW. And has been growing about 30% annually in recent years. The physical of PV cell is very similar to that of the classical diode with a pn junction formed by a semiconductor material .The solar cell is the basic building of the PV power system it produces about 1 W of power. To obtain high power, numerous such cells are connected in series and parallel circuits on a panel (module). The open circuit voltage of a single solar cell is approx 0.5 V. Much higher voltage is required for practical application. Solar cells are connected in series to increase its open circuit voltage.

FONTES. N ET AL [2]: photovoltaic and wind energy are being recognized as cost effective generation sources in small isolated power systems. A realistic cost benefit analysis requires evaluation models that recognize the highly erratic nature of these energy sources while maintaining the chronology and interdependence of the random variable inherent in them . Currently we can observe very fast development of new electrical powe sources called renewable sources. As the wind does not blow all the time nor does the sunshine all the time , solar and wind power alone are poor power sources . hybridizing solar and wind power sourced together with storage fuel cell to cover the periods of time without sun or wind provides a realistic form of power generation . Dedication of land area for exclusive installation of solar arrays might have to compete with other necessities . the amount of land required with utility scale solar power plants currently approximately 1-2 km. for every 20-60 MW. Generated could pose a strain on India's available land resource .Hybrid power system can also be used to reduce energy storage requirements by integrating and optimizing the solar photovoltaic and wind system , the reliability of the system can be improved and the unit cost of power can be minimized. In India the solar wind hybrid power plants are technically approved by the Ministry Of New And Renewable Energy (MNRE) .These solar /wind hybrid power plant generate electricity and can be alternate source for the continuous EB supply is not available .With these systems we can generate , store and use the power as and when required and also for rural electrification.

LIUCHEN CHANG ET AL [3]. : Wind energy system : wind power system convert the kinetic energy of the wind in to other forms of energy such as electricity. Although wind energy conversion is relatively simple in concept, the turbine design can be quite complex. Most commercially available wind turbine uses a horizontal axis configuration two or three blades, a drive train including a gear box and a generator and a tower to support the rotor . co operative research between DOE and manufacturing companies is aimed at increasing the aerodynamics efficiency and structural strength of wind turbine blades . An important factor is how much power your wind turbine will produce is the height of its power. the power available in the wind is proportion to the cube of its speed .This means that if wind speed doubles, the power available to the wind generators increases by a factor of 8 (2*2*2= 8) since wind speed increases with height increases to the tower height can mean enormous increases in the amount of electricity generated by a wind turbine.

Power is directly proportional to wind speed, as the wind speed increases the power delivered by a wind turbine also increases. Finally, if the wind speed is less than the cut in speed or greater than furling speed there will be no output power from the turbine.

1.1 Hybrid Energy System

Hybrid energy system is the combination of two energy sources for giving power to the load. In other word it can defined as "Energy system which is fabricated or designed to extract power by using two energy sources is called as the hybrid energy system." Hybrid energy system has good reliability, efficiency, less emission, and lower cost. In this proposed system solar and wind power is used for generating power. Solar and wind has good advantages than other than any other non-conventional energy sources. Both the energy sources have greater availability in all areas. It needs lower cost. There is no need to find special location to install this system. Many hybrid systems are stand alone systems, which operate "off grid" not connected to an electricity distributed system for the time when neither the wind nor the solar system producing, most hybrid system provide power through batteries and/or engine generator powered by conventional fuels such as diesel. If the batteries run low, the engine generator can provide power and recharge the battery adding an engine generator makes the system more complex, but modern electronic controller can operate this system automatically. And engine generator can also reduce the size of the other components needed for the system. Keep in mind that the storage capacity must be large enough to supply electrical needs during non charging periods after completing the wind turbine and solar power generation we will check the output of the each power source. After successful power generation from both the power source we will combine both the power source.

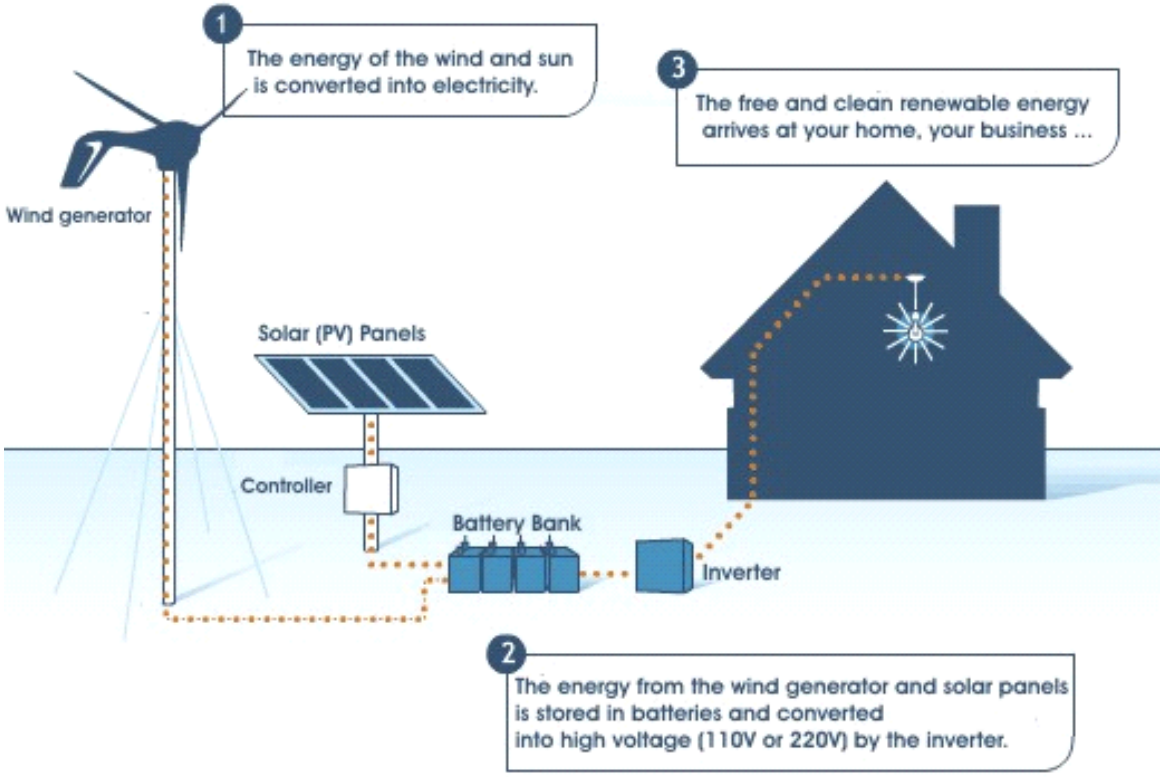

Fig 1

1.1.1 Desing of Hybrid Energy System

For design of the hybrid energy system we need to find the data as follows:

A Data required for Solar System:

1. Annual mean daily duration of Sunshine hours
2. Daily Solar Radiation horizontal (KWH/m2/day)

B. Data required for Wind System:

1. Mean Annual Hourly Wind Speed (m/sec)
2. Wind Power that can be generated from the wind turbine

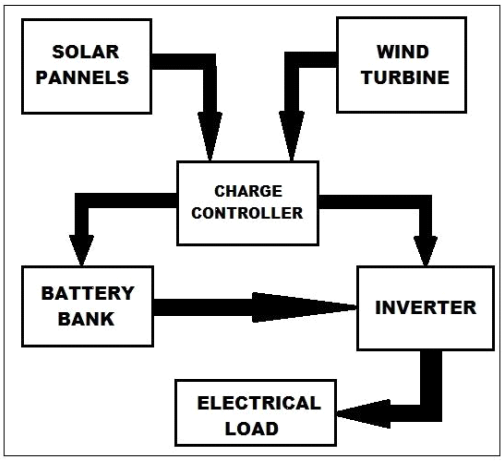

Fig 2

Above figure shows the block diagram of the hybrid power generation system using wind and solar power. This block diagram includes following blocks:

i. Solar panel
ii. Wind turbine
iii. Charge controller
iv. Battery bank
v. Inverter

i. Solar panel

Solar panel is use to convert solar radiation to the electrical energy. The physical of PV cell is very similar to that of the classical diode with a PN junction formed by semiconductor material. When the junction absorbs light, the energy of absorbed photon is transferred to the electron proton system of the material, creating charge carriers that are separated at the junction. The charge carriers in the junction region create a potential gradient, get accelerated under the electric field, and circulate as current through an external circuit. Solar array or panel is a group of a several modules electrically connected in series parallel combination to generate the required current and voltage. Solar panels are the medium to convert solar power into the electrical power.

ii. Wind turbine

Wind turbine is that system which extracts energy from wind by rotation of the blades of the wind turbine. Basically wind turbine has two types one is vertical and another is horizontal. As the wind speed increases power generation is also increases. The power generated from wind is not continuous its fluctuating. For obtain the non-fluctuating power we have to store in battery and then provide it to the load.

iii. Charge controller

Charge controller has basic function is that it control the source which is to be active or inactive. It simultaneously charge battery and also gives power to the load. The controller has over-charge protection, short-circuit protection, pole confusion protection and automatic dump load function. It also the function is that it should vary the power as per the load demand. It add the both the power so that the load demand can fulfil. And when power is not generating it should extract power from battery and give it to the load.

iv. Battery Bank

We have to choose battery bank size per the load requirement so that it should fulfil the requirement of load for calculating the battery bank size we need to find following data:

1. Find total daily use in watt-hour (Wh).
2. Find total back up time of the battery

For increase in battery bank size we need to connect cell in series so that we can get the larger battery bank size.

v. Inverter

We have to choose greater rating inverter than the desired rating .The pure sign wave inverter is recommended in other to prolong the lifespan of the inverter. Inverter is need to convert DC power into AC power. As our load working on the AC supply so we need to convert DC power. The input voltage Output voltage and frequency, and overall power handling depends on the design of the specific device or the circuitry. The inverter does not produce any power. The power is provided by the DC source.

II. CALCULATIONS

The total power generated by this system may be given as the addition of the power generated by the solar PV panel and power generated by the wind turbine.

Mathematically it can be represented as,

$PT = NW * P_W + Ns * PS$

Where,

PT is the total power generated

PW is the power generated by wind turbines

PS is the power generated by solar panels

NW is the no of wind turbine

Ns is the no of solar panels used

2.1 Calculations for Wind Energy

The power generated by wind energy is given by,

Power = (density of air * swept area * velocity cubed)/2

$PW = ½. \rho (AW) (V)^3$

Where,

P is power in watts (W)

ρ is the air density in kilograms per cubic meter (kg/m^3)

AW is the swept area by air in square meters (m^2)

V is the wind speed in meters per second (m/s).

2.2 Calculations for Solar Energy

To determine the size of PV modules, the required energy consumption must be estimated. Therefore, the power is calculated as

PS = Ins (t) * AS*Eff(pv)

Where,

Ins (t) = isolation at time t (kw/ m^2)

AS = area of single PV panel (m^2)

Eff(pv) = overall efficiency of the PV panels and dc/dc converters.

Overall efficiency is given by,

Eff (pv) = H * PR

Where,

H = Annual average solar radiation on tilted panels. PR = Performance ratio, coefficient for losses.

2.3 Calculation for Prototype Load

1. Maximum weight on lift (M_1) = 20gm
2. Force acting on lift ($F_{1)}$ = M*g where g = 9.8 m/s^2
3. = 0.1962 N
4. Torque required (T_1) = F*r = $0.196*3*10^{-2} = 5.88*10^{-3}$ N-m
5. Power consumed (P_1) = 2πNT/60 where N is speed in RPM = 300
6. = 0.1846 W
7. For 2 lifts, power consumed = 0.3692 W
8. Power consumed by pump = 0.8W
9. Total power = 0.8+0.3692 = 1.1692 W
10. Current output by solar panel (I) = 100 mA
11. Voltage output of solar panel (v) = 7.4 V
12. Number of panel used = 2
13. Power output of two panel = 7.4*100*2 = 1.5 W
14. Efficiency of solar panel = $(P_{op}/P_{in})*100$ = 7.5%

2.4 Calculation for Construction Site

1. Maximum weight on lift (M_1) = 200 k_g
2. Force acting on lift ($F_{1)}$ = M*g
   = 1962 N
3. Torque required (T_1) = $F_1*r_1 = 1962*40*10^{-2} = 784.80$ N-m
4. Power consumed (P_1) = $2\pi N_1T_1/60$ where N is speed in RPM = 40
   = 4928.54 ≈ 5 KW
5. For 2 lifts, power consumed ≈ 10 KW

6. Power consumed by pump = 3.728 KW ≈ 4KW

   Total power = 10+4=14 KW

7. Output of one solar panel = 250 W

   Voltage = 30.7 V

   Current = 8.18 A

   S.C current = 8.71 A

   Efficiency = 15.37%

   Power output = 250 W

8. Number of panel required (for 20 KW) = 80
9. Space required for one panel = 1.64*0.992 = 1.5872m^2

   So far 80 panels area required = 126.96≈ 127m^2

10. Power output of wind mill = 5 KW
11. Height of wind mill = 50 ft
12. Diameter of blades – 18 ft
13. Minimum wind speed = 20 Kmph

III. ANALYSIS OF SOLAR AND WIND DATA

3.1 Homer

HOMER is a computer model that simplifies the task of designing hybrid renewable micro grid, whether remote or attached to a larger grid HOMER'S optimization and sensitivity analysis algorithms allow you to evaluate the economic and technical feasibility of a larger number of technology options and to account for variations in technology costs and energy resource availability. Originally designed at the national renewable energy laboratory for the village power program, HOMER is now licensed to HOMER Energy.

HOMER provides the detailed rigor of chronological stimulation and optimization in a model that is relatively simple and easy to use. It's adaptable to a wide variety of projects. For a village or community – scale power system, HOMER can model both the technical and economic factors involved in the project. For larger system, HOMER can provide an important overview that compares the cost and feasibility of different configuration; then designer can use more specialized software to model the technical performance.

HOMER is accessible to large set of users, including non technical decision makers. Chronological simulation is essential for modelling variable resource, such as solar and wind power and for combined heat and power applications where the thermal load is variable. HOMER's sensitivity analysis helps determine potential impact of uncertain factors such as fuel price or wind speed on a given system

The HOMER Hybrid Optimization Modelling Software is used for designing and analyzing hybrid power system, which contain a mix of conventional generators, cogeneration, wind turbine ,solar photovoltaic, hydropower, batteries, fuel cells, biomass and other inputs. The tool can analyze either grid tied or stand alone system and can also perform greenhouse calculations for the measures being considered. HOMER allows the user to input an hourly power consumption profile and match renewable energy generation to the required load.

This allows a user to analyze micro- grid potential, peak renewable penetration, ratio of renewable source to total energy, and grid stability, particularly for medium to large scale projects. Additionally, HOMER contains a powerful optimizing function that is useful in determining the cost of various energy power project scenarios. This functionality allows for minimization of cost and optimization of scenarios based on various factors (e.g., co_2 minimization)

To meet the renewable energy industry's system analysis and optimization needs, NREL started developing HOMER in 1993. Since then it has been downloaded free of charge by more than 30,000 individuals, corporations, NGO's government agencies and universities worldwide.

IV. FIGURES AND TABLES

Fig 3. HOMER Data (Solar Radiation) for Our Visited Site

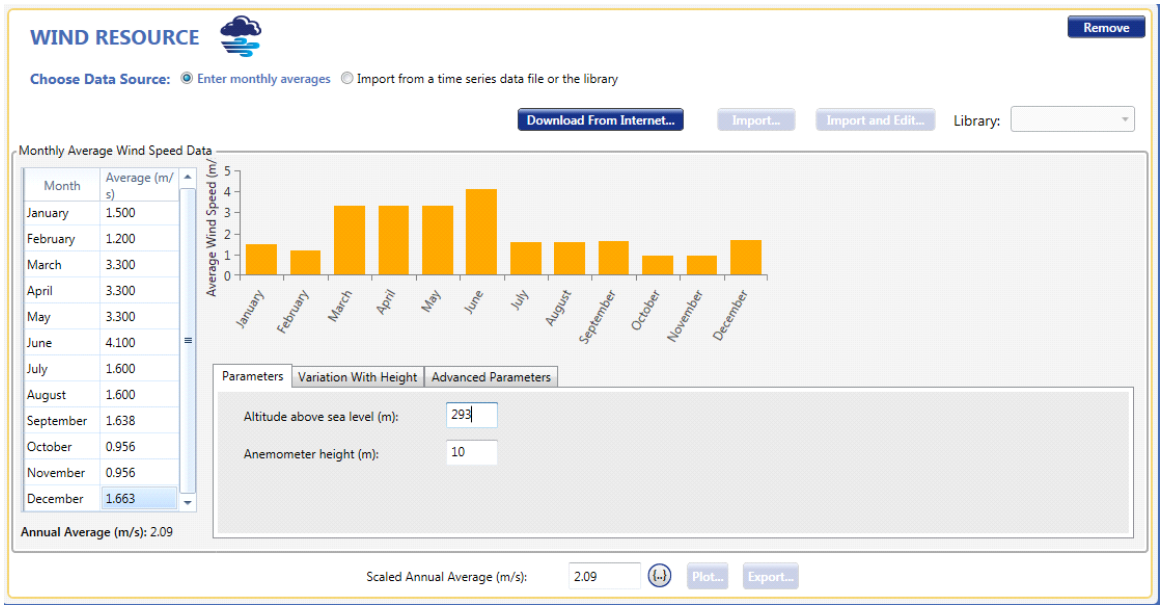

Fig 4. HOMER Data (Wind) for Our Visited Site.

Table 1

EQUIPMENT	PROTOTYPE		CONSTRUCTION SITE		RATIO
	LOAD (Kg)	POWER (Watt)	LOAD (Kg)	POWER (Watt)	
LIFT (Tower+ Monkey)	0.020	0.3692	200	4928.54	1:10000
PUMP	-	0.8	-	3.728	1:4660
SOLAR PANEL	-	1.5	-	15000	1:10000
TOTAL POWER	1.5		15000		1:1000
FORCE	0.1962 (N)		1962(N)		1:10000
AREA	0.5244 (m^2)		36000 (m^2)		1:145666

V. CONCLUSION

Hybrid power generation system is good and effective solution for power generation than conventional energy resources. It has greater efficiency. It can provide to remote places where government is unable to reach. So that the power can be utilize where it generated so that it will reduce the transmission losses and cost. Cost reduction can be done by increasing the production of the equipment. People should motivate to use the non conventional energy resources. It is highly safe for the environment as it doesn't produce any emission and harmful waste product like conventional energy resources. It is cost effective solution for generation. It only need initial investment. It has also long life span. Overall it good, reliable and affordable solution for electricity generation.

VI. ACKNOWLEDGMENT

Authors wish to thanks Jss Academy of Technical Education, Noida, Uttar Pradesh, India. Also like to pay gratitude towards Head of Department, Manufacturing Engineering and Principal Jss Academy Of Technical Education, Noida, Uttar Pradesh, India, for their valuable support and encouragement.

VII. LIST OF SYMBOLS AND ABBREVIATIONS

1. A Area swept by rotor blades
2. ρ Density of air
3. v velocity of air
4. E Energy produced
5. P Power coefficient
6. T Time
7. C_p Power coefficient
8. A_1 Area of solar panel
9. R Solar panel yield
10. H Solar radiation
11. P_r Performance ratio
12. τ Torque
13. F Force
14. L Length or distance
15. M Mass
16. G Gravitation
17. R_s Radius of shaft
18. Eff. Efficiency
19. Ins. Isolation

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