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RESEARCH ARTICLE

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COMPARISON OF PERFORMANCE AND COST OF WIND AND SOLAR HYBRID SYSTEM USING HOMER SOFTWARE

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ABSTRACT
A wind-solar hybrid system is a reliable alternative energy source because it uses solar energy combined with wind energy to create a stand-alone energy source that is both dependable and consistent. Solar power or wind power alone can fluctuate, when used together they provide a reliable source of energy. Wind-photovoltaic hybrid system (WPHS) utilization is more likely to be efficient due to increasing energy costs and decreasing prices of turbines and photovoltaic (PV) panels. Main objective of this paper is to compare stand-alone solar-wind hybrid power system and to maximize use of renewable energy generation system while minimizing the total system cost using HOMER software for Indore region. In this paper economic aspect and efficiency of solar hybrid renewable system is presented. This paper also shows effectiveness of hybrid solar wind system over stand alone solar and stand alone wind system.
Keywords: Wind-photovoltaic hybrid system (WPHS), photovoltaic (PV), HOMER software.

1. INTRODUCTION

The growing depletion of natural resources, renewable energies have attracted much attention among available renewable energy technologies, wind and solar energy are the most promising options [1]. Because of the intermittent solar radiation and wind speed characteristics, which highly influence the resulting energy production, Due to both sources‟ complementary natures, some of these problems can be overcome the weaknesses of one with the strengths of the other. Hybrid energy stations have proven to be advantageous for decreasing the depletion rate of fossil fuels, as well as supplying energy. The hybrid system has more economical alternative for stand-alone solar and wind system.

In the present work, cost and efficiency of solar – hybrid power system is compared with the stand alone solar and stand alone wind system for Indore region. The yearly wind output and yearly solar radiations for Indore regions are collected for the study. The cost and efficiency comparison is performed using HOMER software. The ac primary load of 21 kW/h per day is considered.

II. HOMER

When you design a power system, you must make many decisions about the configuration of the system: What components does it make sense to include in the system design? How many and what size of each component should you use? The large number of technology options and the variation in technology costs and availability of energy resources make these decisions difficult. HOMER, the micro power optimization model, simplifies the task of evaluating designs of both off-grid and grid-connected power systems for a variety of applications. [4].

HOMER software is the micro power optimization model, which is developed by Mistaya Engineering, Canada for the National Renewable Energy Laboratory (NREL) USA. HOMER provides the model with inputs, which describe technology options, component costs, and resource availability. HOMER uses these inputs to simulate different system configurations, or combinations of components, and generates results that you can view as a list of feasible configurations sorted by net present cost.

Optimization and sensitivity analysis algorithms make it easier to evaluate the many possible system configurations. HOMER simulates the operation of a system by making energy balance calculations in each time step of the year. After simulating all of the possible system configurations, HOMER displays a list of configurations, sorted by net present cost (sometimes called lifecycle cost), that you can use to compare system design options.

HOMER also displays simulation results in a wide variety of tables and graphs that help us to compare configurations and evaluate them on their economic and technical merits. It can export the tables and graphs for use in reports and presentations.

III. SOLAR POWER

Solar panels are the medium to convert solar power into the electrical power. Solar panels can convert the energy directly or heat the water with the induced energy. PV (Photo-voltaic) cells are made up from semiconductor structures as in the computer technologies. The solar modules (photovoltaic cell) generate DC electricity whenever sunlight falls on solar cells. The solar modules should be tilted at an optimum angle for that particular location, face due south, and should not be shaded at any time of the day.

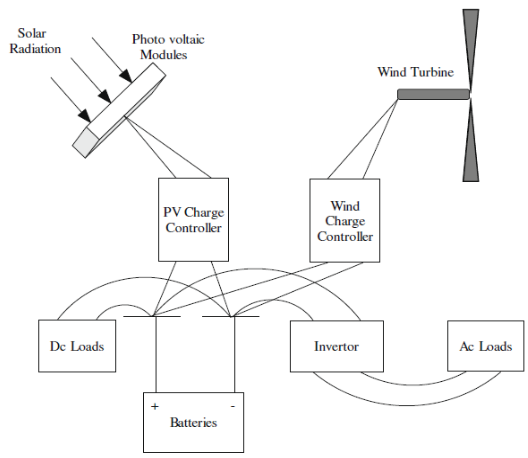

Fig. 1 Systematic structure of WPHS system

IV.WIND POWER

The wind systems that exist over the earth's surface are a result of variations in air pressure. Wind is merely the movement of air from one place to another. The wind turbine captures the winds kinetic energy in a rotor consisting of two or more blades mechanically coupled to an electrical generator. The turbine is mounted on a tall tower to enhance the energy capture.

V. HYBRID SOLAR-WIND SYSTEM

Renewable energy resources like solar and wind offer clean and economically competitive alternatives to conventional power generation where high wind speed and high solar radiation are available. Renewable resources such as solar and wind energy which change randomly are individually less reliable. However, in many regions, when solar and wind resources are combined for power generation, they complement each other by means of daily and seasonal variations. Combining these two renewable energy sources could make the system more reliable, and the system costs might slightly decrease depending on the regional conditions.

V. TEST DATA

HOMER simulations are performed by analyzing energy balance calculations. Three possible options for distributed generation is analyzed for Indore region. The latitude and longitude of Indore region is 22.725298º North and 75.865534º East. Solar and wind input data are collected for tilted panel and average wind speed data at height of 25 m above the earth surface. Table I shows monthly solar radiation and wind speed. The average solar radiation and average wind speed are calculated from this data.

Average solar radiation: 5.63 kwh/m²/day

Average wind speed: 3.07m/s

TABLE I: WIND AND SOLAR DATA

Month	Solar radiation Kwh/m²/day	Wind speed (m/s)
January	4.84	2.57
February	5.77	2.89
March	6.65	2.86
April	7.27	3.38
May	7.48	4.11
Jun	6.09	4.30
July	4.66	3.86
August	4.18	3.27
September	5.24	2.80
October	5.48	2.17
November	5.03	2.22
December	4.59	2.36

VI. SIMULATION

The simulation is performed for three possible combination of solar and wind renewable energy system i.e. standalone solar power system, standalone wind power system and wind-photovoltaic hybrid system (WPHS). A.C primary load of 21 KW/day is considered for simulation. Fig 2-4 shows modeling of standalone solar, standalone wind and WPHS system in HOMER software. The specification used for standalone solar and wind system is as follows.

Wind turbine :

Type: Generic 1 KW

Rated power: 1 KW DC

Life time: 15years

Hub Height: 25m

PV panel:

Slope: 30

Lifetime: 20 years

Battery:

(a) For Solar and Hybrid

Type: Vision 6FM 200D

Nominal Capacity: 200Ah

Nominal Voltage: 12V

(b) For wind power system

Type:Hoppecke 10opzs 1000

Nominal capacity:1000Ah

Nominal voltage: 2V

Primary load

Type: AC

Rating: 21 KWh/day

TABLE II; EQUIPMENT COST

Equipment	Rating	Cost in Rs
Solar panel	1 kw	350000
Wind turbine	1kw	84000
Converter	1kw	12500
Battery	12v 200Ah	10000

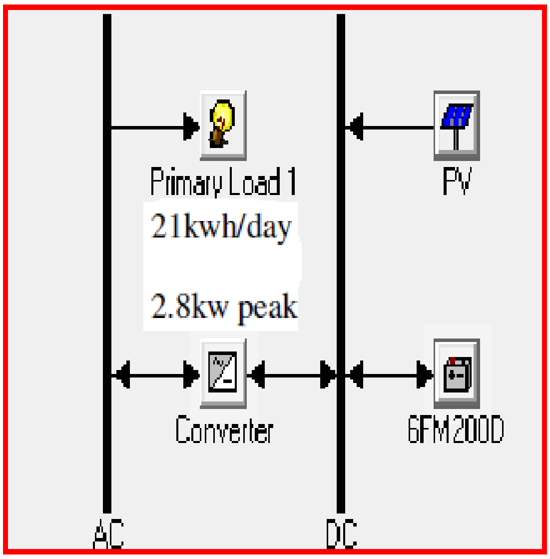

Fig. 2 Modeling of standalone solar system

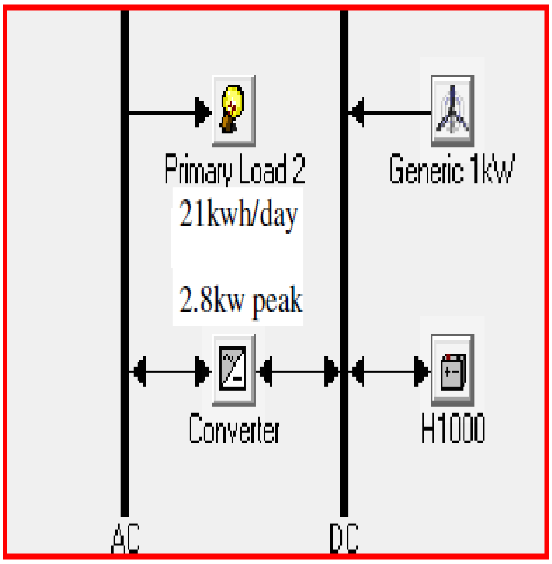

Fig. 3 Modeling of standalone wind system

Along with specifications cost of solar panel, wind turbine, converter and battery is illustrated in Table II.

VII.RESULTS

This section shows the hybrid system is able to feed the power to the ac load of 21kwh/day for Indore region. The sensitivity variables which are to be considered for proposed system are solar radiation, wind speed, fuel cost, and battery cost. The results are evaluated for optimization of cost and efficiency.

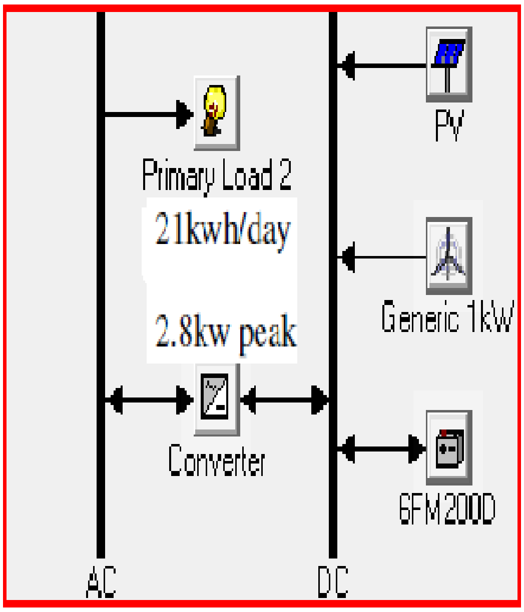

Fig.4 Modeling of WPHS system

TABLE III; SYSTEM COST COMPARISON

System	Initial cost ($)	Operating cost ($/yr)	Total NPC ($)	Cost of energy ($/kwh)
Solar power system	59,950	1,731	82,082	0.884
Wind power system	66,750	1,718	83,432	2.036
Solar-wind hybrid system	46,350	2,413	80,365	0.821

(a) Optimization of cost

The results obtained from optimization are presented in Table III for three possible combinations. The results shows the total net cost (NPC), initial cost, operating cost and cost of energy (COE) for all the three possible combinations for one year. The results suggest that initial cost, Total NPC and COE is better in case of WPHS system, where as operating cost is higher among all the three possible combinations. Result suggests that from the different possible configuration, one can choose the better optimal solution. The hybrid system is most suitable as compared to other and it is suitable to fulfill load demand during the year.

(b) Simulation Results

The simulation result allows only feasible solution with their increasing in number of cost and eliminates all other infeasible possible solutions. Also simulation performs the number of parameters displayed against sensitivity variables to identify optimal solution for energy system. According to the optimal solution the total energy required to satisfy the load demand by the hybrid combination of 90% PV, 10% wind, which is illustrated in Table IV and Table V.

TABLE IV: LOAD TABLE FOR HYBRID SYSTEM

Quantity	Value	Unit
Excess electricity	798	Kwh/yr
Unmeet load	573	Kwh/yr
Capacity shortage	749	Kwh/yr
Renewable fraction	1.00	

TABLE V: ELECTRICAL OUPTUT FOR WPHS SYSTEM

Component	Production (Kwh/yr)	Fraction
PV	8474	90%
Wind turbine	598	10%
Total	9432	100%

The monthly average electric production from wind energy and solar energy in is shown in Fig. 5. Yellow colour indicates electric energy production from solar energy and green colour indicates electric energy production from wind energy.

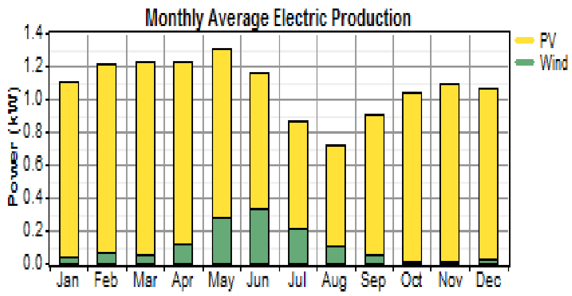

Fig. 5 Average monthly electricity production during the year

VIII. CONCLUSION

In present wok procedure for design of renewable system through HOMER software is studied for Indore location in renewable energy mainly solar (PV array) and wind which are very commonly used. Stand-alone solar system is designed for 5 KW connected load for Indoor domestic consumer. Similarly performance has been evaluated for stand-alone wind and solar energy system for 5 KW Indore region. The following conclusions can be inferred

- Hybrid system is more economical and less costly as compared to stand alone solar and wind.

- Wind input for Indore region is less still hybrid system has greater performance as compared to stand-alone.
- We can effectively design any renewable system through homer software for any desired location.

IX. FUTURE SCOPE AND APPLICATION

In future we will have to use renewable sources because our demand is increasing day by day. We are using energy for many other purposes like heating, cooling, washing, entertainment. In future we will unable to full fill our demands. So Hybrid solar-wind power system is best suitable to full fill our demands because it has negligible disadvantages. It's a second option to optimize the resources and utilize the energy. In future this hybrid system can compensate the demand of power which is not fulfill by other renewable resources such as solar and wind system stand alone. The WPHS system can be extended to following applications:

- Remote and rural village electrification
- Ideal for cell phone recipient stations,
- Residential colonies and apartments for
- general lighting
- Street lighting

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