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Smart Street Light Using Wind-Solar Hybrid Energy System

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Abstract: ***Renewable energy resources such as both energies are becoming advantageous compared to the non-renewable sources of electricity production. Hybrid system for environmental friendly, efficiently and widely available in India. However, the hybrid power system that mainly depends on the intermittent non-conventional energy sources will generate a fluctuating voltage that leads to affect the machines that operate on a constant supply. The combination of this solar and wind energy helps to glow the lamp throughout a year without isolating the generation of electricity in the absence of sun rays.***
Keywords- PV panel, solar tracker, wind turbine, Arduino uno charge controller, Relay module, LED panel.
This chapter includes importance of a photovoltaic model and a wind model. To improve their efficiency is the hybridisation of electricity generated by both sources.

I. INTRODUCTION

A. Global Energy Scenario

Energy, a word everybody is well acquainted with, mathematically means power consumption in a certain span of time. From the first hour of the day till the last hour the daily needs of a man start consuming energy in one form or the other. Nowadays people can't even imagine their lives without energy. A man without a major body part is called to be handicapped; likewise a world without energy is like a crippled world.

Mankind is getting developed year by year and the total population of the world is also increasing as years are passing. As a result, the total energy requirement is also increasing rapidly to keep pace with the rapid modernization of mankind and with the rapid increase in population. According to a survey the primary energy demand is increasing by 1.5% per year and by 2030 the total energy demand will be 16,800Mtoe, with an overall increase of 40% .According to BP Statistical Review of World Energy, world energy consumption got increased by 2.5% in 2011, less than 5.1% in 2010 but well in coordination with the historical average till date.

II. LITERATURE SURVEY

Highly Efficient Tracking Solar Cells for White LED-Based Lighting System : The erawut Jinayimetal. (2007) proposed this system use the dc power generated by fixed solar cells module to energize White LED light sources that are operated by directly connected White LED with current limitation resistor. This paper presents the use of LED as a lighting application powered by tracking solar cells plate and using pulse to apply the electrical power to the LED. A Simplified Life Cycle Assessment applied to Solar and Eolic street light:-

The Scientist P. D. Daidone, L.E. Ascani proposed in this paper about Wind and solar-powered light post as per the United States Design Patent USD626686S in Nov. 2, 2010.This methodology is described and applied to the study of a new type of street light using exclusively wind and solar energy and it is more efficient than the simple solar street lamp. The first approach used in this study does not 'disqualify' the SOLEOL concept, which keeps serious advantages, as far as it has been compared with a 'conventional' street light . This study shows that a street light using 'green energy' could in fact have a seviour impact on the environment than conventional street ligh.

Automatic Aerodynamic Design of a Wind Turbine through Evolutionary Technique : Bhagwan Deen Verma(2020) It is evident from the above study the use of solar trackers will certainly increase the efficiency of SPV systems but proper care is required while installing solar trackers with these systems. Problems such as failure of solar tracker also need equal attention while installing them. Whether to install active or passive solar trackers is also a question which needs to be explored further. This study also tried to analyze all the important factors which are required for the optimization of solar trackers.

A Novel Low Cost Automatic Solar Tracking System : A/C to Carlos Andrés Giraldo-Castañeda and Lionel R. Orama- Exclusa, "Selective Hopping Solar Tracking Method for PV solar panel systems", IEEE International Conference on Sustainable Energy Technologies, ICSET- 2008, 24th -27th November 2008, pp-459 -463.

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In this paper, the hardware of a low cost automatic solar energy trapping system has been designed and successfully implemented. The designed that system which ensures 25 to 30% of more energy conversion than the existing static solar module system.
Lighting Systems Energy Efficiency based on Different Human Visual Conditions:- J. Fraytag, M. F. da Silva, N. B. Chagas, R. N. do Prado, IEEE Member and M. A. Dalla Costa, IEEE Member. In this paper they focused on various artificial lighting sources that are currently marketed can be compared to each other using various criteria such as price, lifetime, and colour rendering index. However, a very important criterion is the luminous efficiency (lumens/Watt), or how much light is emitted per electrical power unit, the latter being directly related to energy efficiency improvements. As a result, it is concluded that using lamps with the adequate light spectrum, light levels can be reduced without visual performance compromising. This implies a considerable lighting systems total power used reduction, without any change in relation to human eye. In the examiner, street lighting study case, one can conclude that the power variation required to maintain the same luminous flux, is considerably high in the different visual conditions.

III. INTRODUCTION TO WORK-STUDY

A. *Work-study*

Work-study is the look over, through a compatible system of the work done in a company to attain the best application of assets. In this project, PV system is combining with wind turbine system to form a renewable energy hybrid system. Since the output of these renewable energy is greatly depends on climatic conditions such as solar irradiance, wind speed, temperature and etc.

1) To monitor the work to achieve work simplification and thereby improve the system's productivity.
2) To evaluate the work content through work measurement.
3) The generation of electricity on bulk amount by hybridizing the two non-conventional energy sources.
4) Capital investment to introduce the latest technology.

B. *Importance of Work Study in Industries*

In industries, work-study is considered as equipment of improving productivity by way of:

1) Resource utilization to a satisfactory level.
2) Capital investment to introduce the latest technology.
3) Better management of the system.

C. *Need for Work-Study*

1) It is a direct means of improving the system's productivity involving very little or no cost.
2) Work-study is the most essential tool of management because:
a) It is a direct means of improving the system's productivity involving very little or no cost.
b) No factor affecting the efficiency of operation is overlooked in this approach.
c) It provides the most accurate means of setting standards of performance which are helpful in the process of production planning and control.
d) Application of work-study result in immediate savings.
e) It is a universal tool for management
f) It is the most competent tool of investigation available to the management of the industrial unit.

IV. METHODOLOGY

1) *Step 1:* Demand Assessment:U sing correct load forecasting of remote villages, the load demand can be fetched. Demand assessment can be done by asking to gram pradhans, college teachers, local people, workers etc.
2) *Step 2:* During load survey, following factors be considered: street light . ,Number of educational premises, commercial, houses, health centers present and the energy required by them, number of small scale industries and their energy demand, Miscellaneous demand.
3) *Step 3:* Resource Assessment :Resource assessment can be occure by calculating available potential in wind, MHP, solar, Biomass, Biogas, and other renewable energy resources using data available.
4) *Step 4:* Barriers/Constraints: Annual electricity demand, monitoring sheet.
5) *Step 5:* . Employment., Net Present cost., Reliability, Environmental factors.
6) *Step 6:* Gather and record the required number of cycles by timing and rating the worker.

7) *Step 7:* Calculating the typical watch time for each element of the operation. Normal time is obtained by multiplying the typical watch time with the rating factor. Normal time is the multiplication of Observed time and rating factor. Calculate the normal time for the total operation by adding the normal time of its various elements.
8) *Step 8:* Add suitable allowances for fatigue and various delays.
9) *Step 9:* Determining the standard time of operation. Standard time = Normal time + allowances.

A. Data Collection

The data gathering is done by recording a video multiple time because we have to do the time study for the existing process and then for the calculation of standard time estimation same method is used for the improved process and its calculation of standard time estimation.

B. Flow Process Chart and Sample Process Chart

Analysis of Data

1) After collecting the data for the existing process and improved process, the data analysis was done.
2) The data analysis was done through brainstorming activity and recording a video in which the element description is gathered for the making of the U bag.
3) After that, the feasible activities to ignore or can be minimized are listed out to minimise the time.
4) The total time of the existing flow process chart and improved flow process chart was calculated separately, and the number of activities was also calculated separately.
5) Then the total time saved was calculated because of minimizing or ignoring some activities in the existing flow process chart.
6) Then time study was done for both the existing process and the improved process, and also, the standard time estimation was done for both the methods.
7) Problems were identified, and accordingly, an action plan was developed.

V. MODELING AND ANALYSIS

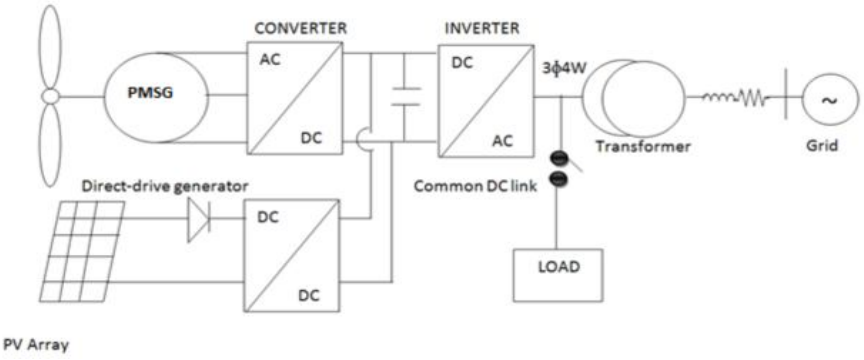


Figure 1: System representing Grid-connected hybrid wind/PV



Figure 2: Model of Proposed hybrid solar-wind system

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V. RESULTS AND DISCUSSIONS

In this thesis, what is effect of position of sun, radiation on panel can be discussed in this chapter. Also the formulae required for the calculation of power generation by wind turbine is specified and calculation of output power by turbine is also calculated here.

A. Battery Backup Calculation

Given data:- Solar panel- 20 watt,
Sunshine hour-8 hr/day (as per the observation)
Load- 6 watt

Total Energy generates/day = 20 watt × 8 hr
= 160 watt hr/day (0.160 Kw hr/ day)
Load rating = 6 watt
I = 6/12
I =0.5 amp
Current consume in A hr. = 0.5×10 hr = 5 A hr.
Battery Backup Calculate:- 5 A hr.
Energy consume by load 10hr/day = 6 watt ×10 hr
= 60 watt hr = 0.06 Kw hr
A 10 watt bulb work in 10 hr/day, as per standard value
1 unit = 1 k watt hr

The total no. of unit for 10 hr. Will 6 watt = 0.006 KW hr
0.006 k watt ×10 hr = 0.06 unit/day
No. of units for 1 year = 0.06 ×365 days
= 21.9 units / year
As per the above calculation the battery gives the back up about 5 hours minimum. But by using solar tracker system the output of the PV is increases to its maximum value which improve the battery backup up to 8 hours which nearly to our projects rated output.

B. Power Generation Calculation by Turbine

The following table shows the definition of various variables used in this model:
E = Kinetic Energy (J), ρ = Density (kg/m3)
m = Mass (kg), A = Swept Area (m2)
v = Wind Speed (m/s), Cp = Power Coefficient
P = Power (W), r = Radius (m)
$\frac{dt}{dw}$ =Mass flow rate (kg/s) , x = distance (m) ,
$\frac{dt}{de}$= Energy Flow Rate (J/s), t = time (s)
The theoretical maximum power efficiency of any design of wind turbine is 0.59 (i.e. no more than 59% of the energy carried by the wind can be extracted by a wind turbine). This is called the "power coefficient" and is defined as:

$$C\ p\ max = 0.59$$

The extractable power from the wind is given by:

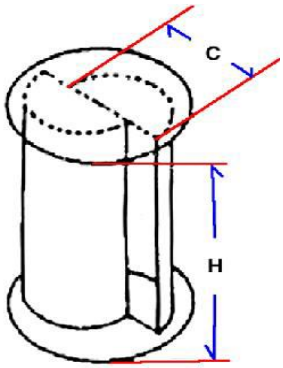
$$P\ avail = \frac{1}{2}\rho A\ v^3 Cp$$

The swept area of the turbine can be calculated from the length of the turbine blades using the equation for the area of a circle:

$$A = \pi r^2$$

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Where the radius is equal to the blade length as shown in the figure below



Swept Area of Model=3.14×0.7^2

=1.533 m. Sqr.

Aspect ratio = Height of turbine / radius of upper circle

Therefore,

Aspect ratio = $\frac{1.5}{0.5}=3$

In this Experimental testing we assume a efficiency of all machinery is near about 40% and the density of air in this region is observed 1.24 kg/m^3.

Thus the power generation is given as follow by using equation is,

P generated (Theoretically= $\frac{1}{2} \times 1.24 \times 2.5^3 \times 1.5 \times 0.40$

=5.8125 watt

C. Discussion

1) The above result gives the idea about the tracking system that how the tracking system improves the voltage and thus it increase the output of PV panel.

2) After comparing the output of PV panel with fixed and rotating mechanism it is seen that the tracking system is more beneficial than the fixed one.

3) The above readings are taken throughout the day from 9 am – 6 pm in which the solar radiation to be maximum.

4) Power calculation gives the power generated by wind turbine, here the efficiency of all the machineries such as turbine generator is taken 40 % as per the standard.

5) While taking the reading the number of problems arises such as cloudy condition interrupts the panel output and suddenly reduce it to the minimum value due to the less solar radiation. Also the wind is not sufficient certain time to take the output of generator.

VI. CONCLUSION

With the implementation of proposed system it conclude that the additional energy generated is around 25-30% with very less consumption by the Solar PV system itself. This model is also useful when sun radiation are unavailable with the use of wind turbine.Hybrid street lamp using LED has better efficiency and luminous with good performance compare to conventional High Pressure Sodium vapour lamp and has proven it is eco-friendly and very economical. Power supply reliability under varying weather condition and the corresponding system cost are the two major concern in designing solar and wind power generation system. In order to utilize renewable energy resources of solar and wind energy both efficiently and economically minimize selecting appropriate system configuration, but also finding size components like wind turbine height , slope angle as given limitation, the investigation result demonstrate the feasibility of the system design carried out by the optimal sizing method presented in this thesis.

VII. FUTURE SCOPE

A. In future we can combine other hybrid system with this existing one like fuel cell or battery system can be added and by using matlab it can be analyzed.

B. During designing the HPS it is important to consider the geographical data to investigate the best combination of the HPS component which most fits the specific area/location. For example, by using wind turbine the system will reduce the dependence on fuel cells at night. Specifically in climates similar to the UK, this could also be used, during winter or cloudy days.

C. Electrolyser can be added to the system. This will utilize the generated unused electricity and generate hydrogen which can be used and stored to fuel the fuel cell.

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D. Using pure Oxygen for the fuel cell instead of air can improve fuel cell efficiency which can be extracted from the electrolyser if included.

E. Improving model accuracy with regard the effect of ambient temperature and wind speed and install temperature sensor and wind speed meter.

F. S-Savonius turbine will replace by S-Spiral type turbine for better performance, output and efficiency at low speed and torque.

G. One axis rotational mechanism can change into two axis rotational mechanism for the rotation of PV module in east to west faces.

H. One can use the Microcontroller or Microprocessor base MPPT (Maximum power point tracking) system to improve the efficiency of PV panel.

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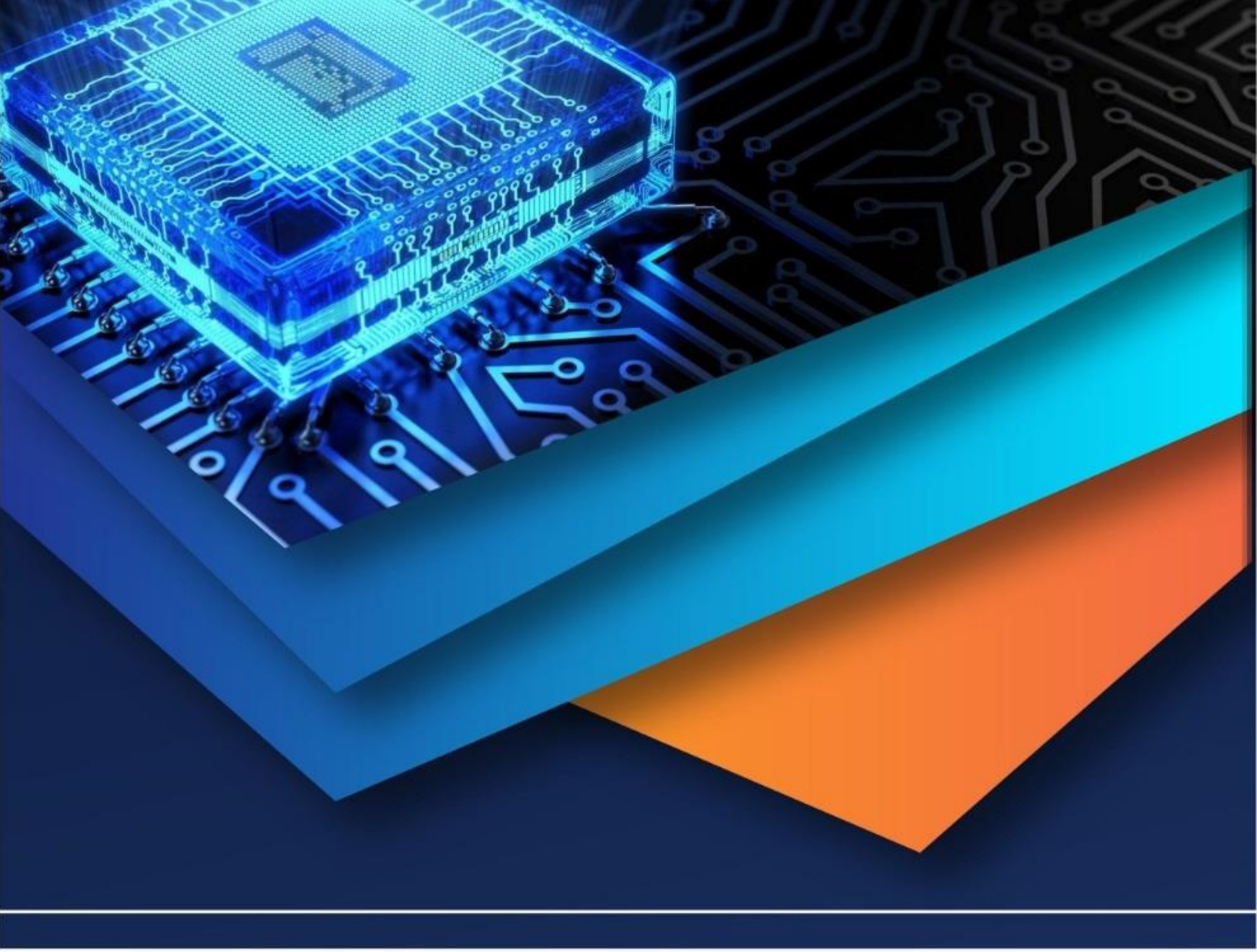
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