Solar and Wind Hybrid Power Generation

Abhishek Tripathi[1], Ashish Jha[2], Utkarsh Singh[3], Prof. R. S. Ambekar[4]
[1, 2, 3, 4] Dept of Electrical Engineering
[1, 2, 3, 4] Bharati Vidyapeeth (Deemed To Be University) College of Engineering, Pune

Abstract- *This paper reflects an independent distributed hybrid power generation system which is composed of solar panel, wind turbine generator, lead storage battery, arduino uno and a bulb acting as a load. A control plan of action has been introduced to maximize the energy that is harvested from both renewable sources simultaneously. The working of the DC charge booster and the operating condition for the solar and wind power has been signified by the process of simulation.[1] Continuous and uninterrupted power can be generated by using the hybrid power generation system. This also involves the synchronization of the power that has been generated from both the sources.[2]*

This project aims to develop a hybrid solar-wind power generation kit which can be used as an experimental setup for renewable energy sources. We have implemented 5watt, 12volt solar panel and wind turbine of 12volt, 1000rpm to fetch the energy from sunlight and wind respectively. A DC charge booster (MT3608) has been to synchronise both the voltages of solar panel and wind turbine .An inverter circuit has been implemented to convert 12volt DC to 12 volt AC and a step up transformer has been to step up the voltage from 12 volt AC to 220 volt AC to glow the bulb of 10watt.

Keywords- DC Charge Booster (MT 3608), Plant Load Factor, Arduino Programming, Current Sensor.

I. INTRODUCTION

Energy is vital for the progress of a nation and it has to be conserved in a most efficient manner. In recent trend, the use of renewable energy technology has been increased steadily due to the increased demand of cheap, abundant and efficient energy supply. However, the problem that arises in this technology are that they are less reliable and has low efficiency. The resources of fossil fuel are insubstantial and they are depleting at a higher rate, so an alternate path has to be provided to introduce the use of renewable resources in different sectors.[3].Although solar energy can be collected during cloudy and rainy days, the efficiency of the solar system drop whereas during a low current of wind the generation through the wind turbine would abruptly fall down. To overcome the above drawbacks, we are making the use of hybrid power generation which would be generating the power simultaneously [4-6] One of the perks of hybrid solar wind power system is its reliability that is at the time of failure of one of the generating unit the other one would be available to meet the demand and when both the resources are available, then the combined energy generated would be highly efficient and continuous demand can be fulfilled. In addition to that, it is pollution free, eco friendly, available in excess. In addition to these, as well as being indigenous and free, renewable energy resources contribute to the reduction of pollution emissions.[7,8]

II. KIT COMPONENT

a. Solar Panel

Type – Polycrystalline silicon solar cell
Max. Power - 5 W
Max. Power Current - 1.5 A
Voltage - 12 V
Dimension - 222 * 270 * 18mm

b. Wind Turbine

Operating Voltage-12V
Speed-1000rpm
No Load Current-0.2A
Power-8W

c. Charge Booster (MT3608)

Current -2A
Voltage Range – 2V-28V

d. Current Sensor

Operating Voltage - 5V
Output Sensitivity - (66-185) mV/A

e. Battery

Type - Lead storage battery
Rating – 12V, 1.3Ah

f. Protection Circuit

It consists of:

Resistor -330ohm
Diode -IN4007
LED

g. Arduino

Type - Arduino UNO ATmega328
Working Voltage -5V
No. of I/O Pins -14
Voltage (input) -(6-20v)
DC Current in each pin – 40Ma

h. LCD

Power Supply-5volt
Duty Cycle -1/16
Module Dimension -80*36mm

i. Inverter

Output Power-15watt
It consists of:
Inductor -10mH
Resistor -220 ohm
Capacitor - 0.1microfarad
Step up transformer - (12V/220V)

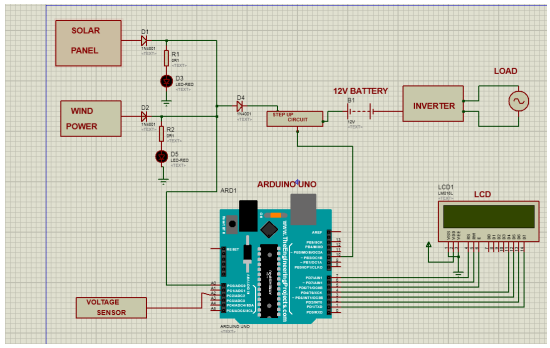


FIG 1. Experimental setup of the kit

FIG 2: Actual Kit

III. DESIGN AND SETUP

The kit consists of the solar panel and wind turbine generator which are brought together by means of DC charge booster to charge the battery .The power from both the sources are stored in the battery. In the solar and wind power generation the DC voltage is generated, so in order to store this DC voltage, lead storage battery is used. A Protection circuit consisting of resistor, diode and led is used to allow the charge to flow only in one direction. A DC charge booster (MT3608) is used to step up both the voltages and synchronise it. It can take input voltage as low as 2V and step up the output to as high as 28V. A current sensor (ACS712) is used to display the current flowing in the battery and the current flowing through the load when it is switched ON. We have used an ARDUINO UNO which is based on the ATmega 328 which is programmed to display the voltages of both the battery and the load when it is turned on. A toggle switch is used to turn on/ off the load. An inverter circuit is used to consisting of RLC Filter to convert 12V DC to 12 V AC further it would be stepped up to 220V AC by using a step up transformer to glow the load as maximum as 10W.

IV. EXPERIMENTS AND RESULTS

a. Proposed calculations regarding plant load factor:

1. Solar Panel:

Rated Power = 5W
Maximum Power = 4W

2. Wind Mill:

Rated Power = 8W
Maximum Power = 7W

3. Connected Load = Rated power of solar panel + Rated power of wind mill

=(5 + 8)W

= 13 W

4. Demand Factor

= Maximum Demand from load side .
Total Connected Load to the system
= 7/13

= 0.538

Practically Demand Factor < 1

Ideally Demand Factor = 1

5. Diversity Factor

$$= \frac{\sum(\text{Individual Maximum Demand})}{\text{Maximum Demand from the load side}}$$

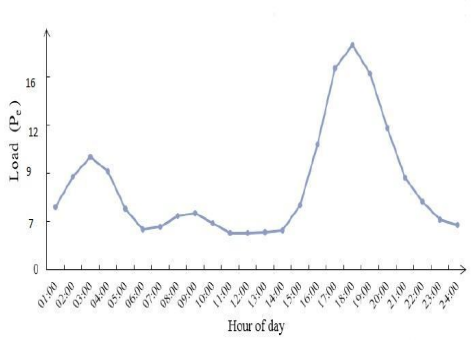
= 11/7

= 1.571

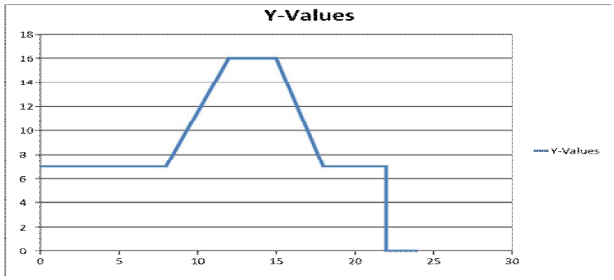
Practically Diversity Factor > 1

Ideally Diversity Factor > 1

6. Load Curve



7. Average Load



$$P_{avg} = \frac{\text{Area under the load curve(Watt hour)}}{\text{Total time (Hours)}}$$

$$P_{avg} = \frac{212.5}{24}$$

= 8.85 Watts

8. Plant Load Factor

= P avg / P max.

= 8.85/11

= 0.804

Or,

Plant Load Factor = (P avg * T)/(P max * T)

= (Area under the curve)/(Rectangular area corresponding to P max)

= 212.5/(11 * 24)

= 0.804

Practically Plant Load Factor < 1

Ideally Plant Load Factor = 1

9. Plant Capacity Factor:

Installed Capacity = 10Watts

$$\text{Plant Capacity Factor} = \frac{P_{avg}}{P_c}$$

$$= \frac{8.85}{10}$$

= 0.885

Practically Plant Capacity Factor <1

Ideally Plant Capacity Factor = 1

b. Wind Turbine Power Calculations:[9]

Calculations:

According to given data:

Length of Blade (l) = 0.1m

Velocity of Wind (v) = 1.0m/sec

Density of Air (ρ) = 1.22 kg/m^3

Power Coefficient, Cp = 0.4

Considering the blade length as the radius of the swept area

We get;

Length(l)=radius(r)= 0.1m

$$A = \pi r^2$$

= π*0.1*0.1

= 0.0314 m^2

Hence, the conversion of energy from the kinetic energy of the wind into rotational energy of the turbine can be obtained from the given formula,

$P_{available}$ = 1/2ρAv^3Cp

= ½*1.23*0.0314*(1.0)^3*0.4

= 0.00772MW

= 7.72W

c. Waveform shown on CRO for

i)SolarPanel

ii)Battery

d. Programming of Arduino:

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(2, 3, 4, 5, 6, 7);

#include<Wire.h>
//voltage
int input;
float volt;
//temp
int val;
//current
#define CURRENT_SENSOR A3
float amplitude_current;
int effective_value;
int P=0;
void volt1()
{
 float vtemp;
 input=analogRead(A0);
// Serial.println(input);
 vtemp=input/4.200;
 volt=(vtemp/10.2);
 volt = volt ;
 lcd.setCursor(0, 0);
 lcd.print("V:");
 lcd.print(volt);
 Serial.print("volt");
 Serial.println(volt);
 delay(1000);
}

void current()
{
   int sensor_max;
     effective_value=analogRead(CURRENT_SENSOR);
     effective_value = effective_value - 400;
     lcd.setCursor(8, 0);
     lcd.print("I:");
     lcd.print(effective_value);
     lcd.print("mA");
     delay(1000);
}
void setup()
{
Serial.begin(9600);
//pins_init();
     lcd.begin(16, 2);
     lcd.setCursor(0, 0);
     lcd.print("SOLAR AND WIND ");
     lcd.setCursor(0, 1);
     lcd.print("  POWER GEN.");
     delay(2000);
     lcd.clear();
}

void loop()
{
volt1();
current();
delay(2000);
lcd.clear();
}
```

V. CONCLUSION

A hybrid power generation system which can drive a load using solar panel and wind mill as energy source will be developed in this project. Hence from the concept of Plant Load Factor, we got Connected Load = 13 watts, Demand Factor = 0.538, Diversity Factor = 1.571, Average Power = 8.85 watts, Plant Load Factor = 0.804 Plant Capacity Factor = 0.885 for 10 watt load.

REFERENCES

[1] Dan Shen Energy Systems and Power Electronics Laboratory, Purdue School of Engineering and Technology, Indianapolis 46202, USA

[2] International Journal of Scientific and Research Publications, Volume 5, Issue 3, March 2015 1 ISSN 2250-3153 www.ijsrp.org Hybrid Power Generation System Using Wind Energy and Solar Energy Ashish S. Ingole*, Prof. Bhushan S. Rakhonde** * Department of Electrical Engineering, DES's COET, Dhamangaon (RLY) ** Department of Electrical Engineering, DES's COET, Dhamangaon (RLY)

[3] V. K. Gajbhiye1 , Prof. A. A. Kanaskar2 , Prof. S. S. Jawre3 1 M. Tech. student, Mechanical Engg. Department, S.S.PA.C.E Wardha, Maharashtra, India

[4] I. A. Adejumobi, S.G. Oyagbinrin, F. G. Akinboro & M.B. Olajide, "Hybrid Solar and Wind Power: An Essential for Information Communication Technology

Infrastructure and people in rural communities", *IJRRAS*, Volume 9, Issue1, October 2011, pp 130-138.

[5] Kavita Sharma, Prateek Haksar "Designing of Hybrid Power Generation System using Wind Energy-Photovoltaic Solar Energy- Solar Energy with Nanoantenna" *Internationa Journal of Engineering Research And Applications (IJERA)* Vol. 2, Issue 1,Jan-Feb 2012, pp.812-815 .

[6] Ravi Dwivedi, Kshitiz Upadhyay, Ankur Kumar Singhand Anant Kumar, "Proposed model for the wind energy harnessing system in trains " International Journal of Applied Engineering and Technology ISSN: 2277-212X , Vol. 1 (1) October-December 2011, pp.119-126.

[7] Master of Science Thesis KTH School of Industrial Engineering and Management Energy Technology EGI-2015-031MSC EKV1087 Division of Heat & Power SE-100 44 STOCKHOLM

[8] Design of a Wind-Solar Hybrid Power Generation System in Sri Lanka M.V.P. Geetha Udayakanthi

[9] RWE npower renewables Mechanical and Electrical Engineering Power Industry, Basic Engineering Mathematics, John Bird, 2007, published by Elsevier Ltd.; Engineering Mathematics, Fifth Edition, John Bird, 2007, published by Elsevier Ltd.