

# SOLAR AND WIND HYBRID SYSTEM FOR LIGHTING APPLICATION

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## Abstract

. One of the essential requirements for financial improvement in any country on the planet is arrangement of solid power supply framework at remote, disengaged and in rustic regions. Sun oriented and Wind half and half framework gives practical and solid alternative of electrical supply. This undertaking is about advancement of cross breed sunlight based breeze control framework that outfits the sustainable power sources from sun and twist all the while to create power. Here DC electrical power delivered from photograph voltaic cell and wind turbines are provided to isolate DC-DC converters which will give controlled DC according to the heap prerequisite at a little model level to bridle sun powered breeze control at the same time. Same framework can be stretched out to nourish extensive burdens.

**Keywords:** Hybrid System Solar, Wind, Choppers

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## INTRODUCTION

Energy is fundamental for the advance of a country and it must be rationed in a most productive manner. Not just the advances ought to be created to deliver power in a most situation inviting way from all assortments of powers yet additionally enough significance ought to be given to save the Electrical power in the most effective way. Vitality is the delegated factor in charge of both horticultural and modern advancement. The utilization of efficient power vitality innovation to meet the vitality requests has been continually expanding for as far back as quite a while, in spite of the essential disadvantages related with sustainable power source frameworks are their failure to guarantee unwavering quality and their lean nature. Import of oil based goods constitutes a noteworthy deplete on our remote trade save. Sustainable power sources would be considered as the better choice to address these difficulties. [2]

In India according to the 2011 provisional population totals of Rural-Urban distribution in country, the population in rural areas is 83.3Crores and around 18000 villages in India are still not electrified due to inherent problems of location and poor economy. The initial expenditure required to install and to maintain the distribution lines in the remote area is considerably high. The transmission losses are also considerably high in remote transmission which results in poor power quality. Like other developing countries India is also facing problems in extension of grid at non-electrified area such as high initial investment, poor voltage regulation, high lead time, frequent power supply interruption and low power factor. At present, renewable energies like solar, wind, water and various form of biomass are the ultimate alternative for the electrification of the remote area as they are naturally available, inexhaustible and pollution free. [1]

## SOLAR ENERGY

“Solar energy is energy from the sun. It is considered as a renewable source of energy because it is inexhaustible and the equipment used to convert the solar energy into electrical energy does not pollute the environment.”

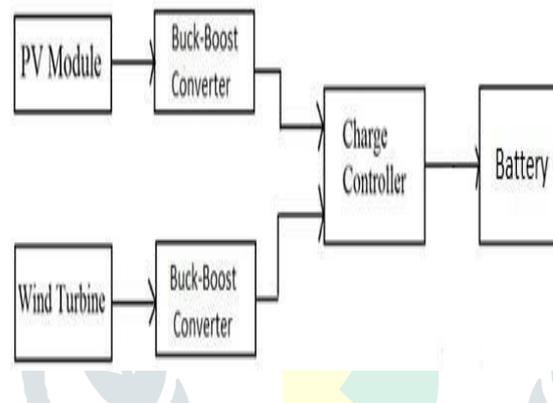
## WIND ENERGY

“The wind has huge amount of kinetic energy. This energy can be converted into electrical energy by wind turbine . ”

## SOLAR AND WIND HYBRID SYSTEM

Sun oriented and wind sources are reliant on the flighty factors, for example, climate and atmosphere conditions. Shortcoming of one framework can be repaid by the quality of another framework. This brings the idea of half breed framework. Winter a very long time with common decreases in sun based irradiance (shorter days) get an expanded power potential breeze vitality. This relationship reaches out to the day by day cycle also. Amid the late morning, wind speeds are ordinarily lower, yet the sunlight based potential is high. Alternately, around evening time winds are more run of the mill, yet there is no power accessible to the P.V. components in the framework. P.V. is operational just amid sunshine hours, which constrains the general creation of a framework. Wind can possibly create 24 hours every day, given the correct conditions, however in particular all through night hours when sun oriented isn't accessible. A half breed approach gives a more secure and even supply of vitality, and gives a vitality floor if an area has occasional shortcomings in the breeze assets accessible. There are areas that, due to occasional varieties in wind assets, don't bolster a breeze just arrangement. In the event that the creation of vitality amid broadened periods isn't ensured, vitality stockpiling necessities to connect the lean circumstances are to a great degree costly, and the arrival on speculation will be too much long. Where both breeze and sun powered are in wealth, the Hybrid framework bode well, particularly in space obliged installations.[3]

### SYSTEM BLOCK DIAGRAM



*Fig 1. System Block Diagram*

### Description of Each Block

#### *PV Module*

A solar cell is a device which generates electrical energy when light falls on it and this is known as photovoltaic effect. Numbers of such cells are either connected in series or parallel to get the desired amount of voltage. And that entire unit is known as solar panel.

#### *Wind Turbine*

It is a device which converts kinetic energy of the air or wind into electrical energy. To get required amount of voltage two or more turbines are either connected in series or parallel.

#### *Buck-Boost Converter*

Buck-boost converter is used to get the desired constant voltage at output. As the voltage generated by the both PV module and Wind turbine will not be constant. So make it constant this converter is used.

#### *Charge Controller*

The charge controller is used to prevent the battery from over charging as well as to prevent the complete discharge. In other words, charge controller controls the rate at which current is added or

drawn from battery. It also senses the temperature of battery and prevents it from overheating and improves efficiency as well as the life span of the battery.

### **Battery**

To store the electrical energy battery is used. Battery stores the electrical energy in the chemical energy. The one way conversion efficiency of it is 80-90%

## **COMPONENTS OF HYBRID SYSTEM**

### **PV Module (Solar Panel):**

**Table 1:** 2 mono-crystalline solar panels with ratings of panel

|                        |        |
|------------------------|--------|
| Maximum output voltage | 16.4V  |
| Maximum power          | 10W    |
| Maximum current        | 0.610A |
| Open circuit voltage   | 21V    |
| Short circuit current  | 0.7A   |

**Table 2:** 2 poly-crystalline solar panels with ratings of panel

|                        |        |
|------------------------|--------|
| Maximum output voltage | 16.4V  |
| Maximum power          | 10W    |
| Maximum Current        | 0.610A |
| Open circuit voltage   | 21V    |
| Short circuit current  | 0.7A   |

**Table 3:** Wind Generator

|                               |        |
|-------------------------------|--------|
| Maximum power                 | 40W    |
| Maximum Output Voltage        | 24V    |
| Rotational Speed of Generator | 900RPM |
| Rotational Speed of Turbine   | 250RPM |
| Generator Turbine Gear ration | 90:25  |

**Table IV:** Battery

|                 |         |
|-----------------|---------|
| Type of Battery | Pb-Acid |
| Voltage         | 12V     |
| Capacity        | 16Ah    |

## **SYSTEM DESIGN**

In this Hybrid system we harness the energy from the sun as well as form the kinetic energy of the wind with the application of the solar cell and wind turbine respectively to increase the overall reliability of the system.

### **Total Load Calculation**

A house with One Bed Room, One Hall and kitchen is considered Two LED with 7 W, 12V Rating is sufficient for illumination of One Room. And one additional LED is needed For Verandah .

So total load = 7 no. LED of 7 W each= 49 W

So Total Load of 50 W is taken for further calculations.

Out of this 50 W load 70% load is considered to be supplied by Solar panel.

### **Sizing of PV Module**

*Solar Irradiation In Surat , Gujarat , India.*

Annual Average: 5.23 (kWh/m<sup>2</sup>/day)[6]

**CALCULATION FOR SIZING OF PV MODULE**

Determine Power Consumption Demands Total Appliances Used,

$$= 50 \text{ W} * 2\text{hr.}$$

$$= 100\text{Wh/day Total PV panel Energy needed}$$

$$= 100 * 1.3$$

$$= 130\text{Wh / Day}$$

Here 1.3 is taken because panel has to generate 30% more energy in order to meet loss. Total Wp of PV panel Capacity needed,

$$= 130/5.3$$

$$= 24.5\text{Wp}$$

Where, 5.3 is average panel generation factor. Numbers of PV panel needed,

$$= 24.53/10$$

$$= 2.453$$

Actual requirement is 3 Modules. [4]

**Sizing of Wind Generator:**

*Wind Data of Surat, Gujarat, India:*

Average Wind Speed: 2.96 m/s

Total load is of 50W out of this 30% of the load is supplied by wind generator and in order to generate 15W the wind generator of 40W capacity is require due to uncertainty.of wind in our state.

**Mechanical design :**

|                      |                          |
|----------------------|--------------------------|
| Pole Height          | 2.1m                     |
| Foundation Dimension | (0.75*1.2)m <sup>2</sup> |
| Shaft Length         | 0.2m                     |
| Gear Ration          | 1:30                     |
| Number of Blades     | 3                        |
| Rotor Diameter       | 1.2m                     |

For less complexity, The design of blades in such a way that power control active blade pitching is not provided. Mechanical Break is also provided on a low speed shaft.

Vanes are provided to remove problema related with broken shaft

The location of this hybrid system is choose according to anual energy density which is greater than or equal to 1000 kWh/m<sup>3</sup>

$$\text{From equation, } \frac{E_g}{A} = \frac{1}{2} \rho \sum_{i=1}^n V_i^3 \Delta t$$

Where,

$$\rho = \text{density of air} = 1.2 \text{ kg/m}^3$$

$V_i$  = average velocity of air

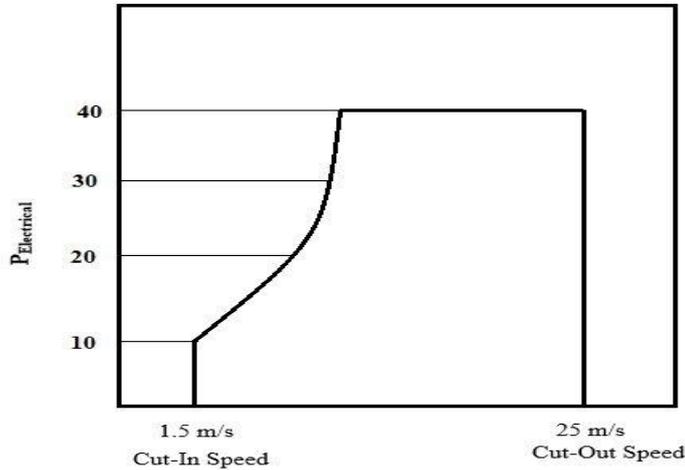
$\Delta t$  = mean frequency distribution

Tip speed ratio,  $\lambda = \frac{\omega R}{v}$

For this system,  $6 > \lambda > 8$

Power coefficient,  $C_p = \frac{P_e}{\frac{1}{2} \rho A V^3}$

For This system  $0.4 < C_p < 0.5$  [10]



**Fig 2.** Output power-speed characteristics for wind generator

Electrical design:

Maximum  $V_{out} = 24V$

Maximum  $I_{out} = 1.67A$

**Battery Sizing:**

Battery size in Ah =  $\frac{\text{total Watt-hour used per day}}{0.85 \cdot 0.6 \cdot \text{nominal battery voltage}}$

Battery size in Ah =  $\frac{100}{0.85 \cdot 0.60 \cdot 12}$   
= 16.33 Ah

Converter Design Calculation

For buck mode

$$L > \frac{V_{out} \cdot (V_{inmax} - V_{out})}{f_{sw} \cdot V_{inmax} \cdot I_{out} \cdot K_{ind}}$$

$$L > \frac{14.5 \cdot (24 - 14.5)}{1000 \cdot 24 \cdot 1.5 \cdot 0.4}$$

$$L > 9.5 \text{ mH}$$

For boost mode

$$L > \frac{V_{inmin}^2 \cdot (V_{out} - V_{inmin})}{f_{sw} \cdot I_{out} \cdot V_{out}^2 \cdot K_{ind}}$$

$$L > \frac{6^2 \cdot (14.5 - 6)}{1000 \cdot 1.5 \cdot 14.5^2}$$

$$L > 2.25 \text{ mH}$$

**SIMULATION:**

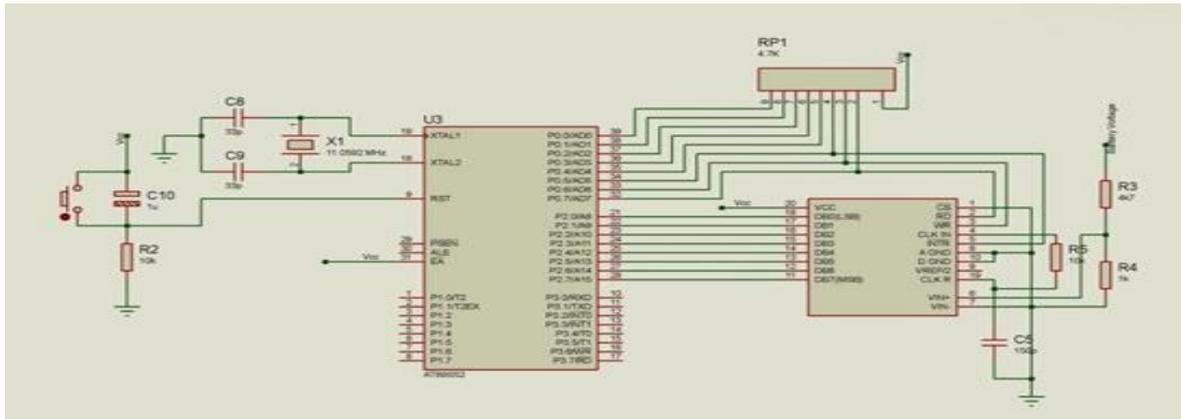


Fig 3. Mosfet Triggerring Circuit Using Microcontroller AT89S 52

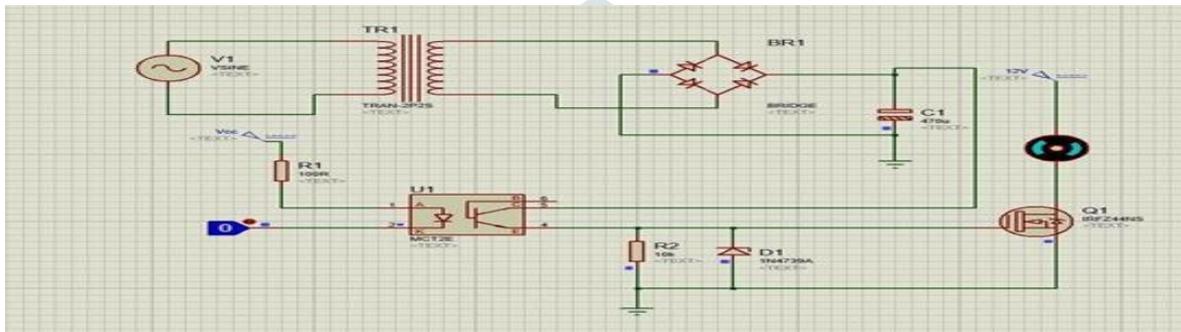


Fig 4. When output from the microcontroller is low

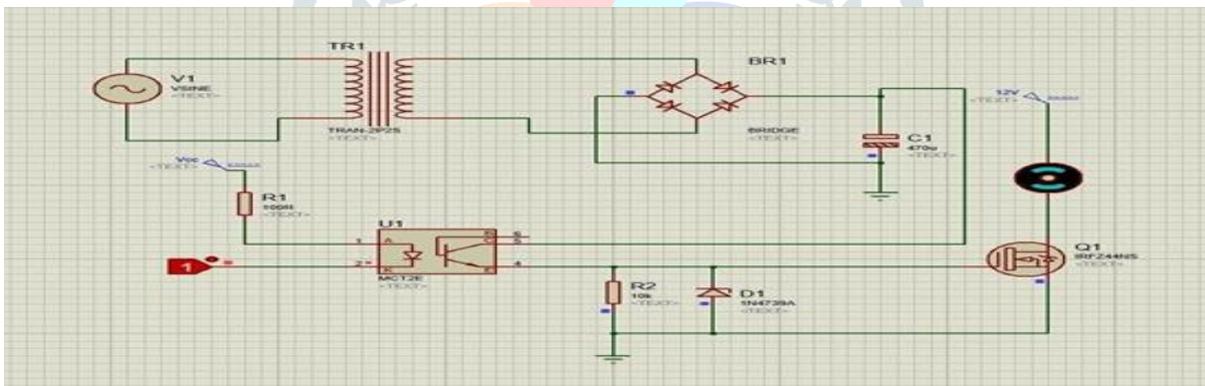


Fig 5. When out of microcontroller is high

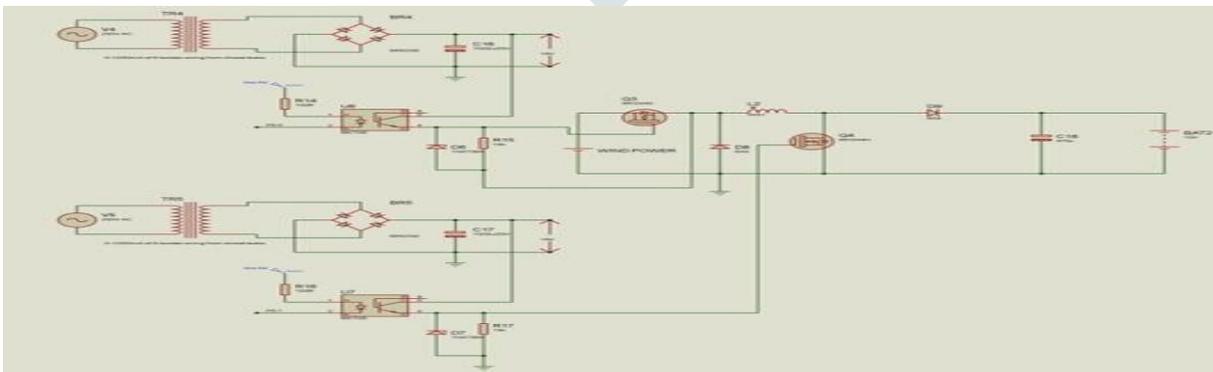
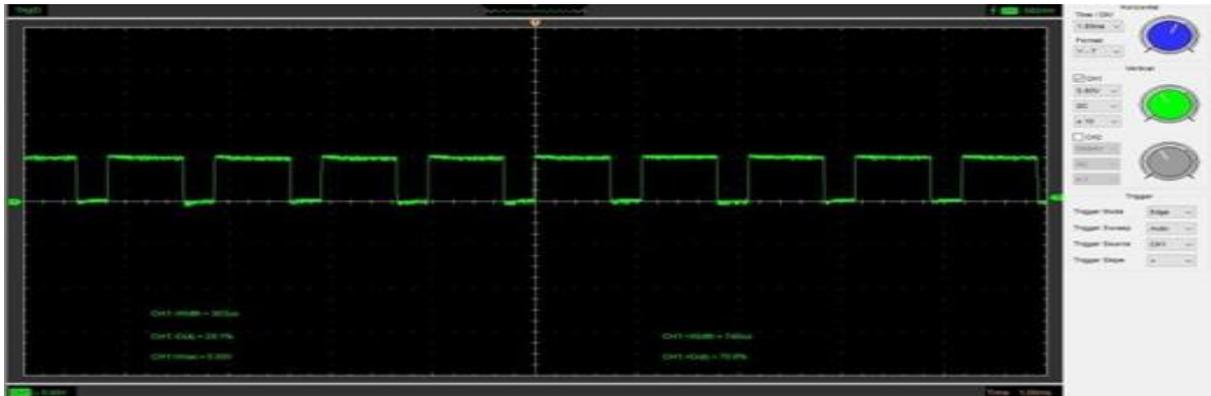


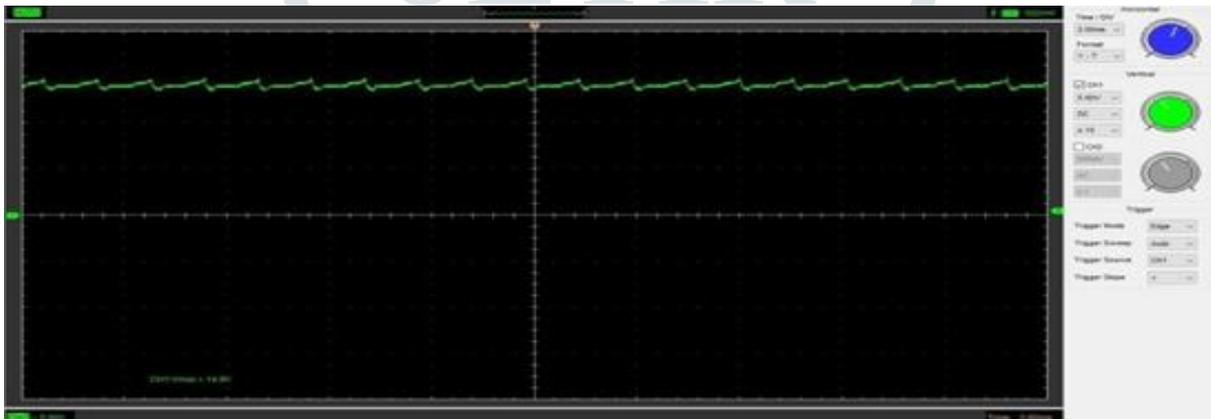
Fig 6. Buck boost Converter

**RESULTS:**

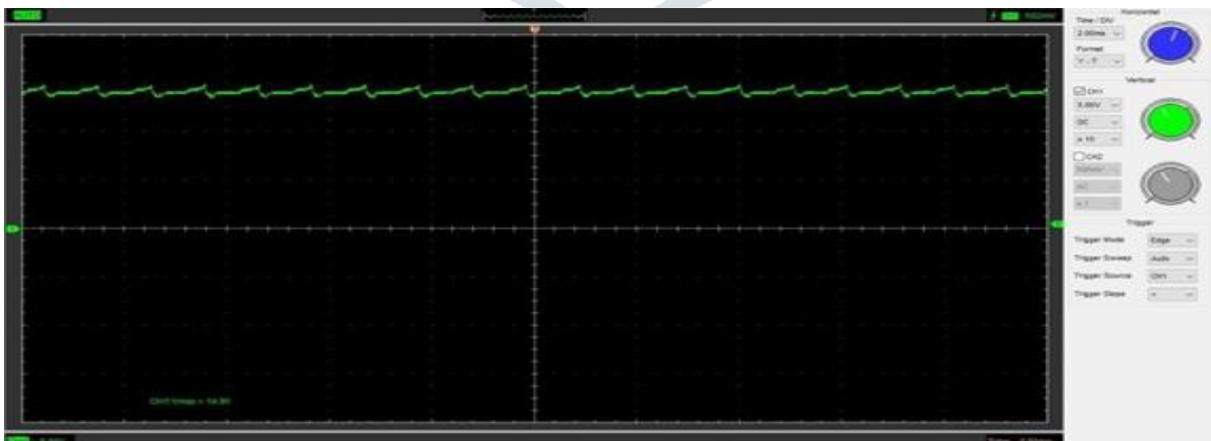
For 5V input

*Gate Pulse***Fig 7. Gate pulses**

Here pulse width for on time is 29.1% and for off time is 71.9%.

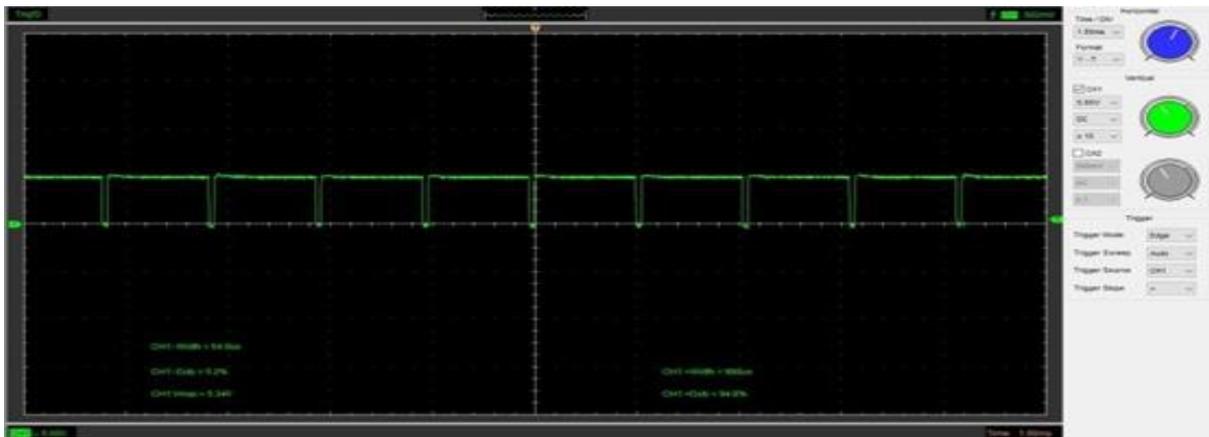
*Load Voltage***Fig 8. Load voltage**

Load voltage obtained is 14.9V

*Capacitor Voltage***Fig 9. Capacitor voltage**

Capacitor voltage obtained is 14.9V.

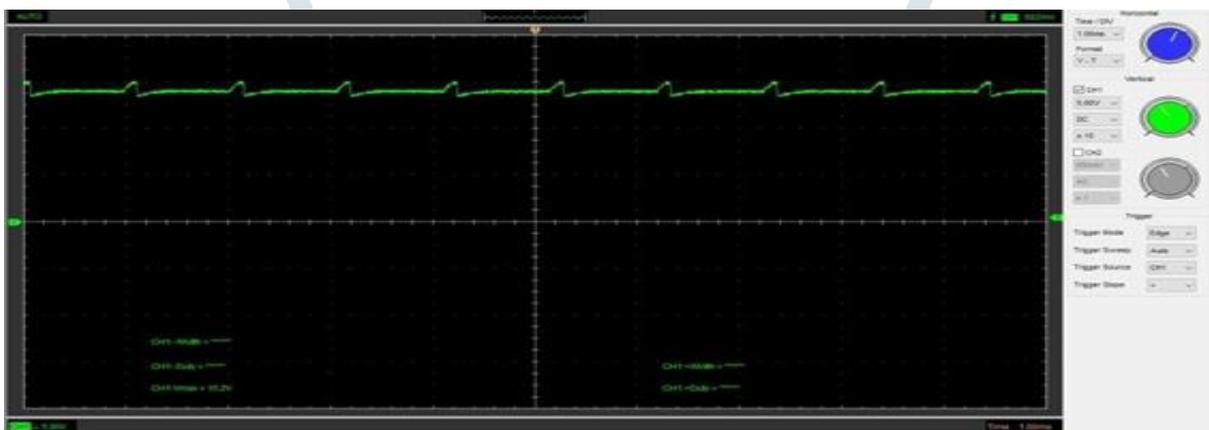
For 24V input  
*Gate Pulse*



**Fig 10. Gate pulses**

Here pulse width for on time is 5.2% and for off time is 94.8%

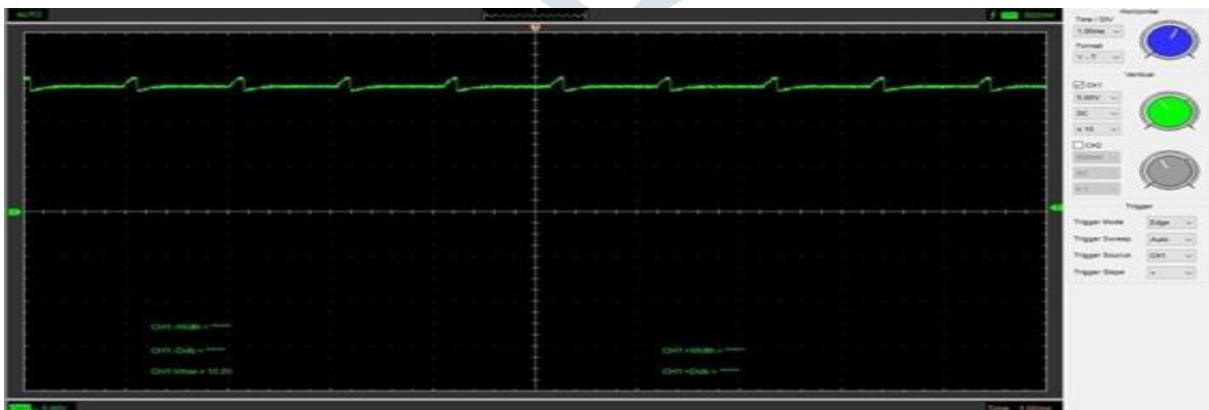
*Load Voltage*



**Fig 11. Load voltage**

Load voltage obtained is 15.2V.

*Capacitor Voltage*



**Fig 12. Capacitor voltage**

Capacitor voltage obtained is 15.2 V.

**CONCLUSION:**

From this whole procedure, it is concluded that the integration of renewable energy sources will be highly effective in all places. Although initial cost for solar wind hybrid power system is high, it produces electricity at least cost which directly lead to the welfare of people and rural development. This shows the high reliability of solar wind hybrid system for multi- purposes. Thus, combined hybrid generating system of variable speed wind generator and photo voltaic array can be integrated to supply various facilities such that cost of energy is minimized

**REFERENCES:**

1. DR. Vadirajacharya, DR.P.K.Katti, "Rural electrification through solar and wind hybrid system: self-sustained grid free electric power source" ,Elsevier May 2012
2. M. Muralikrishna, V. Lakshminarayana, "Hybrid (solar and wind) energy system for rural electrification", ARPN Journal of Engineering and Applied Sciences 2008
3. <https://www.windstream-inc.com/resources>
4. [http://www.leonics.com/support/article2\\_12j/articles2\\_12j\\_en.php](http://www.leonics.com/support/article2_12j/articles2_12j_en.php)
5. <http://www.synergyenviron.com/tools/solar-irradiance/Surat%252CGujarat%252CIndia>
6. <http://www.ti.com/lit/an/slva535a/slva535a.pdf>
7. S. Masri, P.W.Chan, "Design and development of dc-dc boost converter with constant output voltage", IEEE XPLORE June 2010
8. S.Masri, Norizah Mohamad, HAFEEZ MOHAMED HARIRI, "Design and development of dc-dc buck converter for photovoltaic application", IEEE XPLORE July 2012
9. R.K. Akikur, R.Saidur, H.W.Ping, "Comparative study of standalone and hybrid solar energy system suitable for off grid rural electrification" , Elsevier November 2013
10. Sukhatme SP , Nayak JK , Solar Energy Principles of Thermal Collection and Storage.3rd ed.New Delhi , Tata McGraw-Hill Publishing Company Limited ; 2008.