DELHI
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UNIVERSITY

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# BME-A

# VERTICAL AXIS WIND TURBINE FOR HIGHWAY APPLICATION

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# CANDIDATE'S DECLARATION

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We, **Parth Johri** (2K20/B17/033), **Dhruv Bihani** (2K20/B17/044) students of B.Tech I$^{st}$ Year **(BME)** hereby declare that the project "**Vertical Axis Wind Turbine for Highway Application**" which is submitted by us to the Department for Basic Mechanical Engineering, Delhi Technological University for **— "BASIC MECHANICAL ENGINEERING MID-TERM PROJECT 2021"** in partial fulfilment of the requirement for the award of the degree of Bachelor of Technology, is original and not copied from any source without proper citation. This work has not previously formed the basis for the award of any Degree, Diploma Associateship, Fellowship or other similar title or recognition.

*Place*: Delhi

**Parth Johri**
(2K20/B17/033)

Date: 10/07/2021

**Dhruv Bihani**
(2K20/B17/044)

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# CERTIFICATE

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I hereby certify that the project Dissertation titled "**Vertical Axis Wind Turbine for Highway Application**" which is submitted by Parth Johri ,Dhruv Bihani (2K20/B17/33, 2K20/B17/44) [Electronics and Communication Engineering & Mechanical Engineering], Delhi Technological University, Delhi in complete fulfilment of the requirement for the award of the degree of the Bachelor of Technology, is a record of the project work carried out by the students under my supervision. To the best of my knowledge this work has not been submitted in part or full for any Degree or Diploma to this University or elsewhere.

Place: Delhi

Dr. M Zunaid
(Assistant Professor)

Date:
10th July'21

**SUPERVISOR**

**DELHI TECHNOLOGICAL UNIVERSITY**
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# ABSTRACT

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This report is made to highlight the importance of Wind Energy , the energy which can impact our life in a number of ways; we will not only discuss about this in detail but also tell about a number of applications of them in today's world. Wind energy is one of the non- conventional forms of energy and it is available in affluence. Electricity can be generated with the help of vertical axis wind turbine. This projects aims of utilizing this wind energy in most effective manner to get the maximum electric output, and therefore we selected highway as our installation site where we can take the advantage of the moving vehicles on both the sides of the road. In the present work, turbine is design and fabricated as per the specifications, the blades used are semi-circular shape and are connected to the disc which is connected to shaft. Shaft is then coupled with pulley with the help of bearing, and then pulley is connected to the alternator , which generates the power . The power developed is stored in battery and then can be used for street light, signal or toll. In this project a small model has been created for testing purpose. This project also aims for maximum output with minimum cost indulges, so that the government can think over this project and can implement this type of vertical axis wind turbine on highways at low cost.

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# ACKNOWLEDGEMENT

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# CONTENTS

# INTRODUCTION

## VERTICAL AXIS WIND TURBINE FOR HIGHWAY APPLICATION

Wind is caused due to uneven heating of earth's surface, atmosphere, irregularities of earth's surface and rotation of the earth about its own axis. The amount of wind flow depends on various factors such as earth's rotation speed and difference in temperature of places. Energy produced by this blowing wind is called as wind energy.

Electricity plays and vital role for development of the country, so the production of electricity is one of the main aims of the country. About 68% of the production of electric energy is based on thermal power plant, where fossil fuels, coals, diesel are used for power generation and which is very less available and this fuels also creates pollution, greenhouse effect and global warming. Therefore power generation with the help of non-conventional resource such as wind is increasing day by day and this type of power generation is very clean and safe. The wind turbines are basically of two types

1) Horizontal axis wind turbine (HAWT).

2) Vertical axis wind turbine (VAWT).

HAWT has successfully evolved in making of electricity from wind. However, recently working on VAWT has also been started due to its additional advantage over HAWT such as it does not require yaw mechanism because it can produce power independent of wind direction. VAWT can be produced at low cost then HAWT and also affordable maintenance cost.

VAWT are further classified as

1) Savonious vertical axis wind turbine

2) Darrieus vertical axis wind turbine

3) Giro mill.

# EMISSIONS OUTPUT FOR A WIND TURBINE

Power plants, including wind farms, also use electricity and generate pollution when they are being built, maintained and eventually demolished.

One study found that the environmental pollution from wind turbine manufacturing, use, and decommissioning is offset by the benefits of operating the wind turbine for just one year

Cradle-to-Grave Power plants, including wind farms, also use electricity and generate pollution when they are being built, maintained and then demolished at the end of their lifespan. The cumulative greenhouse gas emissions, from "cradle-to-grave3 " for the most common electricity generation sources . The units for comparing total emission are in grams of carbon dioxide equivalent[4] per kilowatt hour of electricity or gCO2 eq/kWhe.

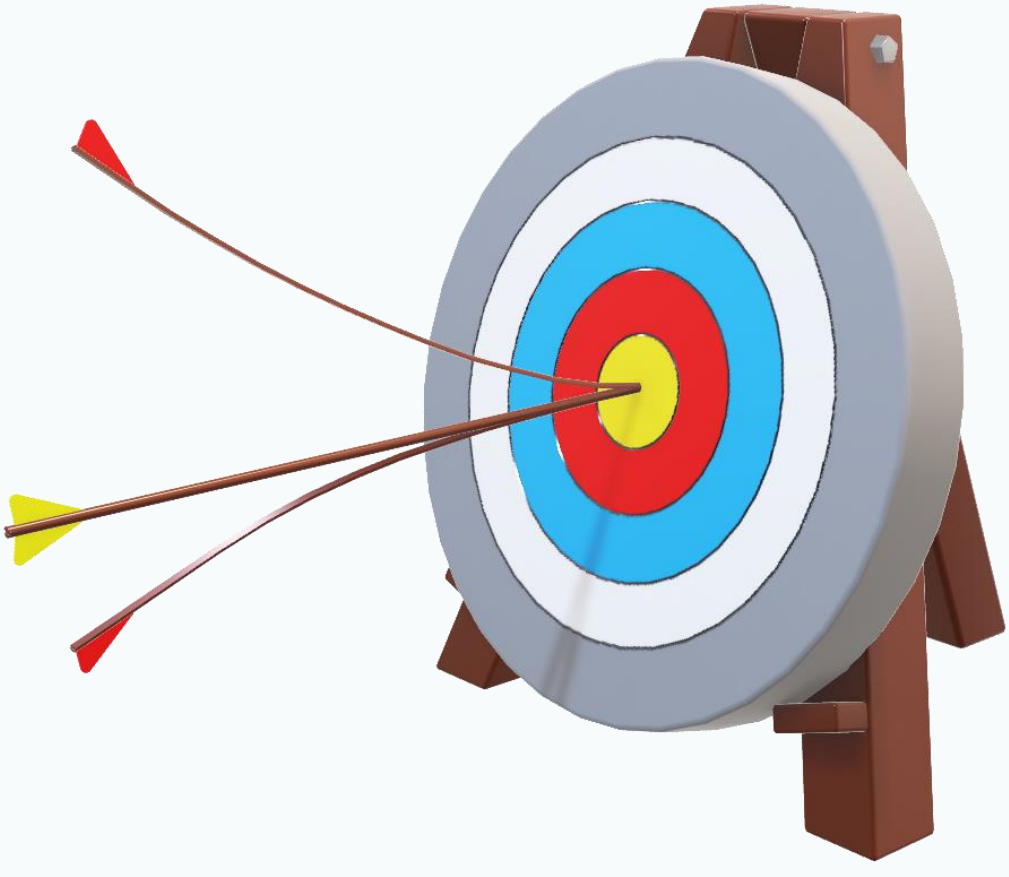
A majority of the greenhouse gas emissions (72-90%) associated with wind generated electricity occurs when the turbines are being constructed. Offshore wind turbines require large amounts of concrete and steel for their foundations, so their construction produces more emissions than onshore wind turbines. A relatively small amount of emissions will occur while maintaining wind turbines. In contrast, the majority of the emissions associated with fossil fuel based electric

Other scientists have reached similar conclusions on the life-cycle emissions of wind turbines. For example, Crawford and colleagues estimated that a **3.0 MW** utility-scale wind turbine would avoid nearly **123,000** tons of greenhouse gas emissions over **20 years** even after accounting for pollution emitted during turbine manufacturing and operation . Martinez and colleagues found that the environmental pollution from wind turbine manufacturing, use and decommissioning is offset by its use in less than one year (its "**energy payback**"). They also estimated that a **2 MW** wind turbine produces **34 times** more energy than is used in its manufacture, use and decommissioning

# OBJECTIVE OF PROJECT

The main objective of our project is to use the maximum amount of wind energy from vehicle running on highways. The wind turbine will be placed in divider so that the tangential acting airflow from both sides of the road due to moving vehicle will help the turbine to rotate. The variation of blade angle is made so as to get the maximum output and blades are then fixed.

The unused considerable amount of pressurized air used to drive the vertical axis wind turbine from which the kinetic energy of turbine is converted into electrical energy. The main aim of this project to reduce the pollution produced burning of fossil fuel. The generated energy by VAWT and solar system are stored in a battery and this stored energy which can be used street lighting, toll gates or in future to provide the charging node to the electrical vehicle.



# WORKING PRINCIPLE

The moving vehicle on highway may be all types such as small or heavy vehicles. Whenever vehicle moves on both side of the highway divider then some pressurized air is produced due to the speed of vehicle. This pressurized air is strike on the blade of vertical axis wind turbine and turbine makes a rotation. The shaft of the vertical axis wind turbine is connected to generator with the help of gear mechanism. The generated electricity is an alternating quantity; the output of the generator is rectified by rectifier and stored in the battery. The solar system is mounted on besides of the vertical axis wind turbine, the function of the solar system not only generate the electricity but also provides the constant air flow towards the blade of vertical axis wind turbine. The position of solar plates is in inclined nature at an angle 45 degree.

A solar cell or photovoltaic cell is an electrical device that converts the energy of light directly into electricity by the photovoltaic effect, which is the physical and chemical phenomenon. It is photoelectric cell, defined as a device whose electrical parameter such as current, voltage or resistance varies when exposed light. Solar cells are the building blocks of photovoltaic modules. The generated electricity is stored in the battery. The stored energy used as a street lighting and domestic purpose.

# BLOCK DIAGRAM

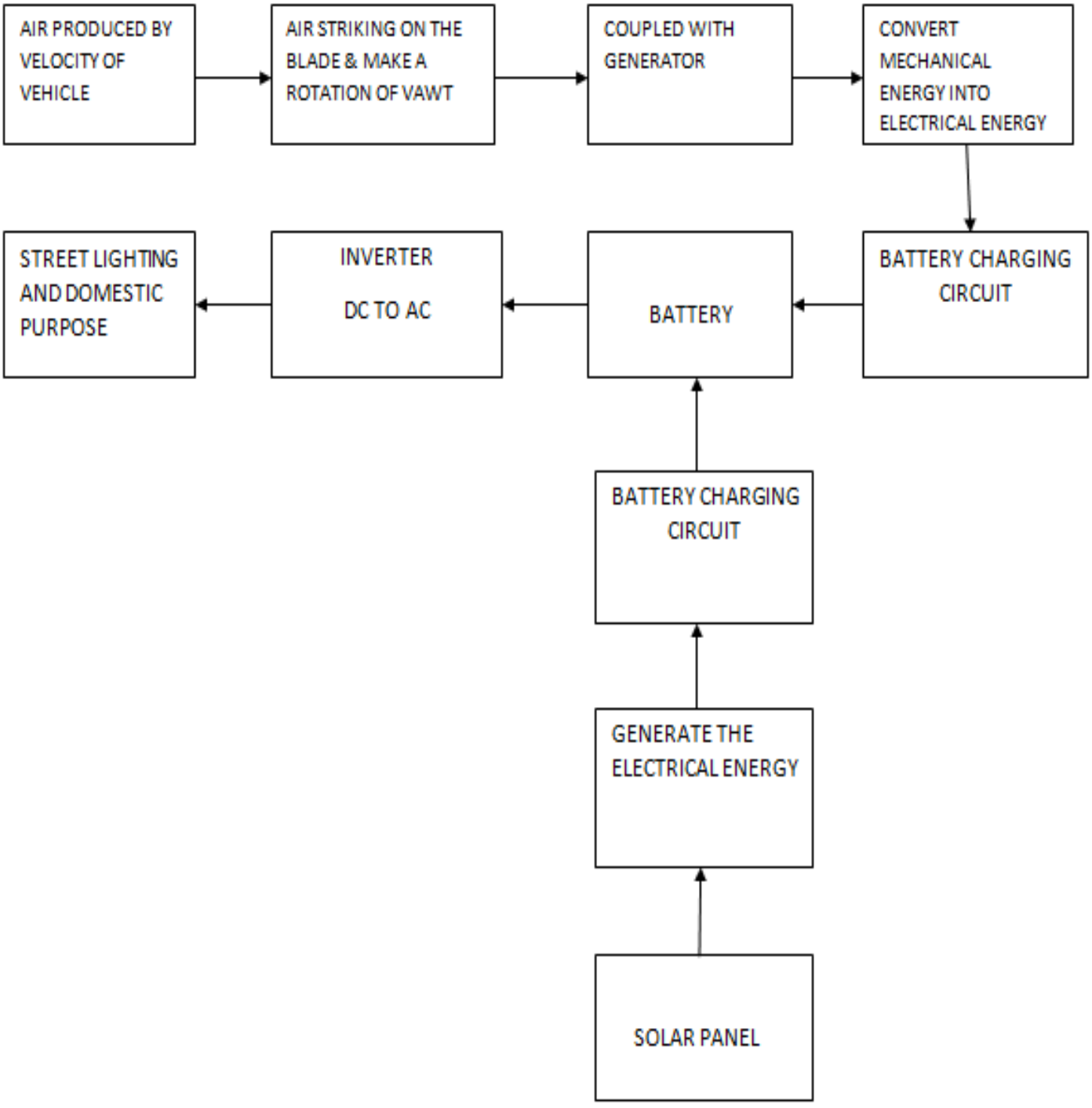


**Fig 1 :** Proposed Model of Vertical Axis Wind Turbine

## MATERIAL USED

The materials for blades, shaft, pulley, disc, L- joint are listed below.

| Sr. no | Compo nent | Cost | Material | streng th | durab ility |
|---|---|---|---|---|---|
| 1 | Blade | Low | Polyviny l chloride (PVC) | low | low |
| 2 | Shaft | Low | G.I. steel | low | low |
| 3 | Pulley | Mode rate | Aluminiu m | high | high |
| 4 | l-joint | Low | G.I. steel | low | low |

## DESIGN OF COMPONENTS

Design calculation of the VAWT is done by considering the speed of the air impacting blades of the turbine it starts rotating, blades connected to generator that generates the power. The power is used for some useful work

### 1) DESIGN OF BLADE

The blade is designed in semicircular shape so as one blade passes another blade comes in the position of first. 8 blades are used so as to use of maximum utilization of wind from air and moving vehicle.

$$A = d*h$$

**d**= diameter of the rotor (**m**)
**h**= height of the blades (**m**)
So,**area** = **(0.75*0.4)**

= **0.3 sq. m.**

This height and diameter is chosen due to restriction of use of more rotor diameter due to available of less space to install on highway.

The blade is made of PVC pipe. This material is taken because it is low-cost and the weight of these pipes is also less, due to this the project weight also decreases and due to this the rotational speed also increases so as output. The weight of each blade is 200gm and therefore the total weight of 8 blades is 1.6 kg.

## 2) DESIGN OF SHAFT

While designing the shaft it should be properly fitted to blade.. The shaft has diameter of 10mm so as to easily fixed in the disc and at the top and bottom ends mild steel plates are attached of thickness 2mm.

Stress acting on shaft $\rho = P/A$
$600 = 0.2898 / \pi/4\ d*d$ So,

$d = 0.0201$
Material used for shaft = Mild steel Syt = 300Sut = 500-600

**Shaft**

## 3) DESIGN OF PULLEY

There are 2 pulley used one big pulley and one short. Big pulley is attached to the shaft and lower pulley is attached to the dimmer dynamo. big pulley is made up of aluminum alloy so as to decrease its weight so it can rotate freely. Both the pulley are attached with the help of a belt. This pulley increases the rotational speed of the turbine.

Diameter of big pulley: 226 mm Inner diameter: 75 mm
Diameter of small pulley: 35 mm Inner diameter: 10mm

## 4) DESIGN OF BEARING

For the smooth operation of Shaft, bearing mechanism is used to .. The Bearing has diameter of 1cm. Bearing are generally provided for supporting the shaft and smooth operation of shaft. For Ease of Performance We have used Ball bearing

# THE VARIOUS OPERATIONS INVOLVED IN FABRICATION PROCESS

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The following were the fabrication techniques involved

1. Primary shaping process
2. Machine process
3. Gas Cutting
4. Arc Welding
5. Surface finishing

# THEORETICAL POWER CALCULATION

The wind mill works on principle of converting kinetic energy of the wind in to mechanical energy. The K.E. of any particle is equal to the one half of its mass times the square of its velocity, or 1⁄2 mv2.
K.E. =1⁄2 mv2. ..... (1)
K.E = kinetic energy
m= mass
v = velocity,

M is equal to Volume multiplied by its density ρ of air,
Mass = ρ AV ..... (2)

Substituting eqn (2) in eqn (1) We had got,

K E = 1⁄2 ρ AV3 watts ρ = density of air (1.225 kg/m3)

**A= l*b (Sq.m)**

**D = diameter of the blade**

**A = l*b**

A = 0.3 Sq.

Available wind power

**Pa = (1⁄2 ρ π D2 V3)/4**

**P = 1/8 ρ π D2 V3**

**TRAIL 1**

**FOR VELOCITY 4.5m/s**

Pa = (1⁄2ρπD2V3)/4

Pa = (1⁄2*1.225*π*0.4*0.4 *4.53)/4

Pa = 7.1watt

**TRAIL 2**

**FOR VELOCITY 5.5m/s**

Pa = (1⁄2ρπD2V3)/4
Pa = (1⁄2*1.225*π*0.4*0.4 *5.53)/4

Pa = 15.1watt

**TRAIL 3**

**FOR VELOCITY 7.5m/s**

Pa = (1⁄2ρπD2V3)/4
Pa = (1⁄2*1.225*π*0.4*0.4 *7.53)/4

Pa = 33 watt

**TRAIL 4**

**FOR VELOCITY 10m/s**

Pa =(1⁄2ρπD2V3)/4
Pa = (1⁄2*1.225*π*0.4*0.4 *103)/4

Pa = 77watt

# TESTING AND RESULTS

**TABLE 2**

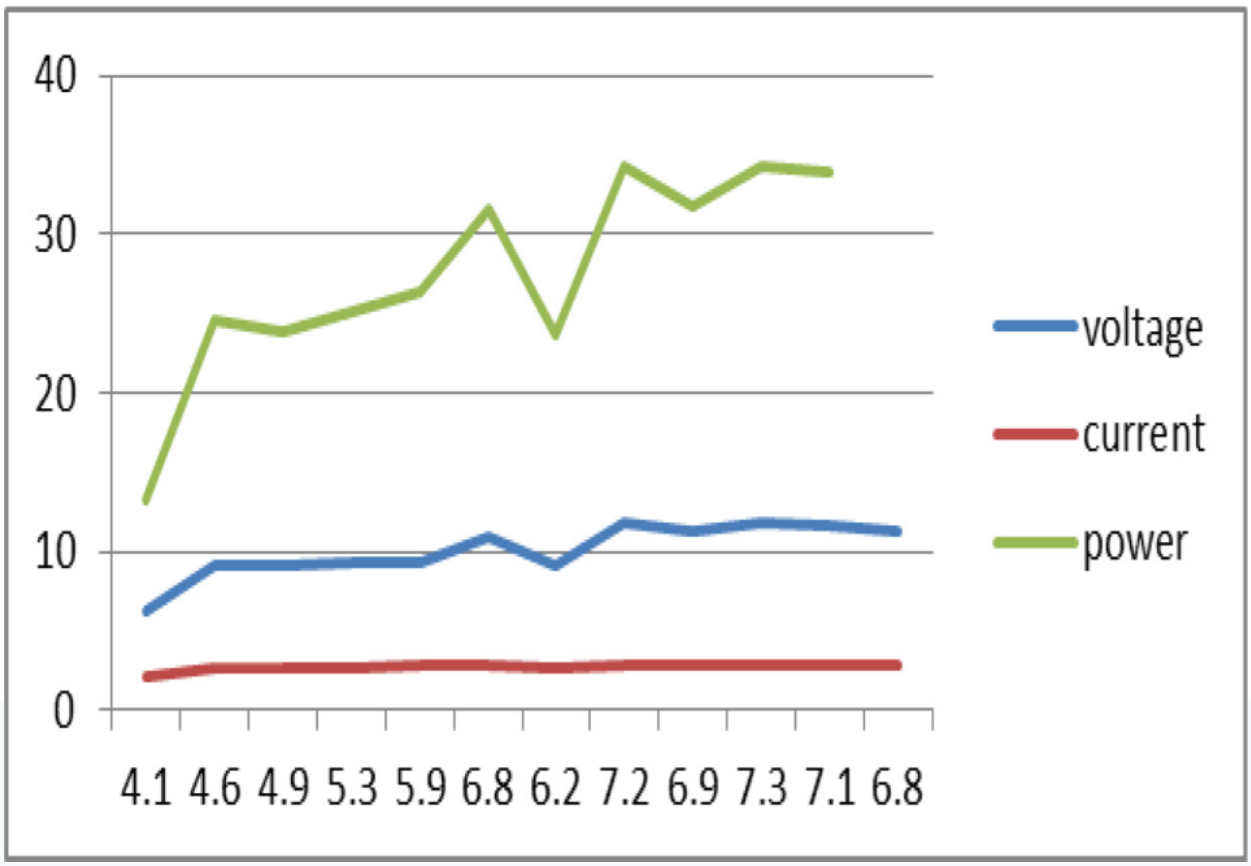
**TESTING**

| Sr.no | Wind speed in m/s | Speed of the shaft | Voltage |
|---|---|---|---|
| 1 | 2 to 3 | 109 to 121 | 3.9 |
| 2 | 3 to 4 | 189 t0 201 | 4.8 |
| 3 | 4 to 5 | 271 to 320 | 6.2 |
| 4 | 5to 6 | 328 to 353 | 8.8 |
| 5 | 6 to 7 | 390 to 396 | 9.2 |
| 6 | 7 to 8 | 400 to 409 | 12 |

## TABLE 3

### SECOND TESTING WITHIN INTERVAL OF 5 MINUTES

| Interval of 5 minutes | Wind Speed m/s | Voltage Volts | Current Ampere | Power Watts |
|---|---|---|---|---|
| 1 | 4.1 | 6.3 | 2.1 | 13.3 |
| 2 | 4.6 | 9.1 | 2.7 | 24.5 |
| 3 | 4.9 | 9.2 | 2.6 | 23.9 |
| 4 | 5.3 | 9.3 | 2.7 | 25.1 |
| 5 | 5.9 | 9.4 | 2.8 | 26.4 |
| 6 | 6.8 | 10.9 | 2.9 | 31.6 |
| 7 | 6.2 | 9.1 | 2.6 | 23.7 |
| 8 | 7.2 | 11.8 | 2.9 | 34.3 |
| 9 | 6.9 | 11.3 | 2.8 | 31.7 |
| 10 | 7.3 | 11.8 | 2.9 | 34.3 |
| 11 | 7.1 | 11.7 | 2.9 | 33.9 |
| 12 | 6.8 | 11.3 | 2.9 | 32.8 |
| Avg | 6.1 | 10.1 | 2.8 | 28.3 |




**GRAPH 1**
**VOLTAGE CURRENT AND POWER GRAPH**

# CONCLUSION

The VAWT is designed and fabricated in such a way that the it can able to capture wind from all the direction, power developed from the project is 28W for a speed of 6.1m/s, the efficiency of VAWT can be increase by changing the size and shape of the blade, the theoretical and experimental result is varying because in theoretical calculation we consider the wind is hitting all the eight turbine blades, practically it is not.

Our work and the results obtained are very encouraged that vertical axis wind energy conversion are plausible and potentially very contribute to the production of the clean renewable electricity from the wind even under low ideal sitting conditions. With the idea on highway, it will power up street lights. In most cities, highways are a faster route for daily commute and in need of constant light makes this a very efficient way to produce natural energy.

This system is environmental friendly. The working model of our project is combined energy source with solar system and vertical axis wind turbine system which is a good and effective solution for power generation, basically this system involves the combination of two energy system, suppose anyone source fails to generate another source will keep generating the electricity and will give the continuous power to the load. The renewable energy sources such as solar and wind energy are used to generate the electricity.

# FUTURE SCOPE

1) As this is proposed model it is built at very low cost. Instead of plastic, if Fiber Reinforce Plastic (FRP) is used it will yield to more output.

2) The Word hybrid means a thing which is made by the combination of more than one element. In energy system, electricity can be produced by more than one source at a time like Wind, solar, biomass etc. There are various methods to generate hybrid energy like wind-solar, Solar- diesel, Wind- hydro and Wind – diesel. Among the above listed hybrid energy generation module the wind- Solar hybrid module are more crucial because it is available abundant in nature and it is also very much environment friendly.

The hybridization in India has large prospect because over 75 % of Indian household face the problem like power cut specially in summer.

So solar panel can be installed on the top of the turbine so that the efficiency increases.

3) Development of effective alternator and dynamos can be used to wind energy from relatively small winds.

4) By setting different angles at different speed of the turbine can also be done as a future work or scope.

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