# HYBRID HIGHWAY POWER GENERATION: A SUSTAINABLE APPROACH TO HARNESSING WIND AND SOLAR ENERGY

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**Abstract -** 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 project 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.

*key word :-Vertical axis & horizontal axis wind turbine , fabrication .*

## 1. Introduction :-

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 ow depends on various factors such as earths 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 68production 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 the 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)

## 1.1 Importance and Present Implementation

Energy is a hot topic in the news today: increased consumption, increased cost, depleted natural resources, our dependence on foreign sources, and the impact on the environment and the danger of global warming. 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. The aim of the project is to utilize the maximum amount of wind energy and hence highway is selected as the installation site.

A wind turbine that generates power from passing traffic is the latest clean energy breakthrough to feature on the streets of Istanbul, Turkey.

The vertical devices, known as ENLIL, are able to harness air currents created by moving vehicles to produce energy, along with soaking solar power at the same time.

Researchers at Istanbul Technical University worked with a team at tech firm Devecitech to create the roadside mechanism.

The breeze produced from passing cars might not seem like much, but ENLIL's long, unobtrusive, upright blades are powerful enough to produce one kilowatt of energy an hour.

A single turbine fitted with an additional solar panel on top can seamlessly produce enough electricity to power two Turkish households for a day.

## 1.2 Wind and Solar Energy

Wind energy is a renewable energy source that uses wind to generate electricity.

Advantages of wind energy:

- Wind is free.

- No fossil fuels are used to generate electricity.

- Newer technologies make energy production much more efficient.

Wind turbines take up less space than the average power station (a few square feet for the base). The turbines can be placed in Highways, High Raised Buildings, remote locations, such as o shore, mountains and deserts. When combined with other alternative energy sources, wind can provide a reliable supply of electricity.

Solar energy is radiant light and heat from the Sun that is harnessed using a range of ever evolving technologies such as solar heating, photovoltaics, solar thermal energy, solar architecture, molten salt power plants and artificial photosynthesis.

Active solar techniques include the use of photovoltaic systems, concentrated solar power and solar water heating to harness the energy. Passive solar techniques include orienting a building to the Sun, selecting materials with favorable thermal mass or light-dispersing properties, and designing spaces that naturally circulate air Solar power is the conversion of sunlight into electricity, either directly using (PV), or indirectly using concentrated solar power (CSP).

## 2. Materials used :-

A fully functional vertical axis wind turbine (VAWT) system with a solar panel includes various essential mechanical and electrical components. The major components of the VAWT system consist of blades, a shaft, a pulley, a disc, and an L joint, as listed below.

**Table 1. Materials Used**

| Sr. no | Component | Cost | Material | Strength | durability |
|---|---|---|---|---|---|
| 1 | Blade | Low | Polyvinyl chloride (PVC) | low | low |
| 2 | Shaft | Low | G.I. steel | low | low |
| 3 | Pulley | Moderate | Aluminium | high | high |
| 4 | l-joint | Low | G.I. steel | low | low |

## 2.1 Design of Components

The design calculation of the VAWT is based on the speed of the air impacting the turbine blades, causing them to rotate. These rotating blades are connected to a generator, which produces power that is utilized for useful work.

## 2.2 Design of Blade

The blade is designed in a semicircular shape so that as one blade passes, another blade moves into the position of the first. Four blades are

used to maximize the utilization of wind from both the air and moving vehicles.

The area is calculated as:

$$A = d \times h$$

Where:

d = diameter of the rotor (m)

h = height of the blades (m)

Thus, the area is:

$$A = 0.75 \times 0.4 = 0.3 \text{ sq. m.}$$



**Figure 2.1 Blades**

## 2.3 Design of Shaft

During the design of the shaft, it must be properly fitted to the blade. The shaft has a diameter of 10 mm to ensure it can be easily fixed into the disc. Mild steel plates with a thickness of 2 mm are attached to the top and bottom ends. Stress acting on shaft $\rho = P / A$

$$600 = 0.2898 / \pi/4 \; d*d$$

So, d = 0.0201

Material used for shaft = Mild steel

$S_{yt} = 300 \; S_{ut} = 500\text{-}600$



**Figure 2.2 Shaft**

## 2.4 Design Of Pulley

Two pulleys are utilized: a larger one and a smaller one. The larger pulley is connected to the shaft, while the smaller pulley is attached to the dimmer dynamo. The larger pulley is constructed from aluminum alloy to reduce its weight, allowing it to rotate more freely. Both pulleys are linked together using a belt. This pulley system enhances 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



**Figure 2.3 Pulley**

## 2.5 Design Of Bearing

For the smooth operation of Shaft, bearing mechanism is used. 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.



**Figure 2.2 Bearing**

# 3. The various operations involved in fabrication process :-

The following were the fabrication techniques involved :-

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

# 4. Theoretical power calculation :-

The windmill operates on the principle of converting the kinetic energy of the wind into mechanical energy. The kinetic energy (K.E.) of any particle is equal to one-half of its mass (M), which is equal to the volume multiplied by the density (ρ) of the air.

Mass = ρ AV    ………………….. (2)

Substituting eqn (2) in eqn (1) We had got,
K E = ½ 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 = (½ ρ π D2 V3)/4
   P = 1/8 ρ π D2 V3

TRAIL 1
  FOR VELOCITY 4.5m/s
  Pa   = (½ ρ π D2 V3)/4
  Pa   = (½*1.225*π*0.4*0.4 *4.53)/4
  Pa   = 7.1watt

TRAIL 2
  FOR VELOCITY 5.5m/s
  Pa   = (½ ρ π D2 V3)/4
  Pa   = (½*1.225*π*0.4*0.4 *5.53)/4
  Pa   = 15.1watt

TRAIL 3
  FOR VELOCITY 7.5m/s
  Pa   = (½ ρ π D2 V3)/4
  Pa   = (½*1.225*π*0.4*0.4 *7.53)/4
  Pa   = 33 watt

TRAIL 4
  FOR VELOCITY 10m/s
  Pa   = (½ ρ π D2 V3)/4
  Pa   = (½*1.225*π*0.4*0.4 *103)/4
  Pa   = 77watt

# 5. Testing and Results :-

**Table 2. Testing**

| Sr.no | Wind speed m/s | Speed of the shaft | Voltage |
|-------|----------------|--------------------|---------|
| 1 | 2 to 3 | 102 to 121 | 4.2 |
| 2 | 3 to 4 | 181 t0 201 | 5.8 |
| 3 | 4 to 5 | 285 to 320 | 6.28 |
| 4 | 5to 6 | 328 to 353 | 9.22 |
| 5 | 6 to 7 | 395 to 396 | 9.8 |
| 6 | 7 to 8 | 402 to 409 | 14 |

**Table 3. Second testing within interval of 5 minutes**

Mass times the square of its velocity, or ½ mv2.

   K.E. =½ mv2. ………………….. (1)

K.E = kinetic energy   m = mass   v = velocity,

| Interval of 5 minutes | Wind Speed m/s | Voltage Volts | Current Ampere | Power Watts |
|-----------------------|----------------|---------------|----------------|-------------|
| 1 | 4.1 | 6.4 | 2.5 | 16.1 |
| 2 | 4.5 | 9.5 | 2.7 | 25.6 |
| 3 | 4.9 | 9.8 | 2.8 | 27.4 |
| 4 | 5.3 | 9.2 | 2.6 | 23.9 |
| 5 | 5.9 | 9.4 | 2.5 | 23.1 |
| 6 | 6.8 | 10.9 | 2.8 | 30.5 |
| 7 | 6.2 | 9.8 | 2.7 | 26.5 |
| 8 | 7.2 | 11.9 | 2.5 | 29.8 |
| 9 | 6.9 | 11.5 | 2.8 | 32.2 |
| 10 | 7.3 | 11.6 | 2.6 | 30.3 |
| 11 | 7.1 | 11.8 | 2.9 | 34.2 |
| 12 | 6.8 | 11.4 | 2.8 | 31.9 |
| Avg | 6.1 | 10.8 | 2.9 | 31.3 |
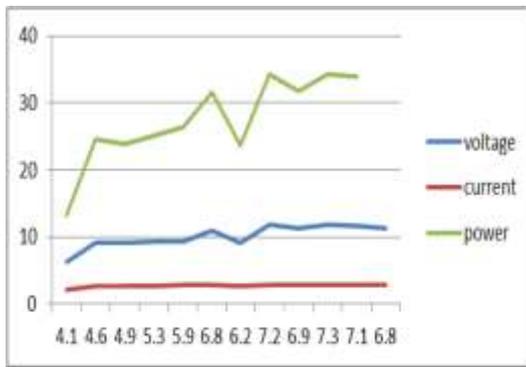
**Graph 1. Voltage Current and Power Graph**

# 6. 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.

# 7. 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 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.
3) 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.
4) Development of effective alternator and dynamos can be used to wind energy from relatively small winds.
5) By setting different angles at different speed of the turbine can also be done as a future work or scope.

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